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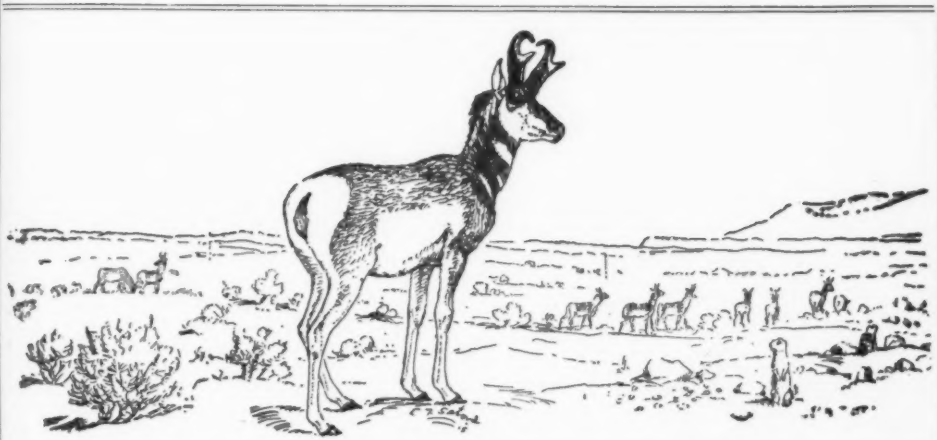

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JOURNAL OF MAMMALOGY

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A CENSUS OF THE PLEISTOCENE MAMMALS OF RANCHO LA BREA, BASED ON THE COLLECTIONS OF THE LOS ANGELES MUSEUM[1]

BY CHESTER STOCK

INTRODUCTION

The magnificent collection of mammalian remains procured by the Los Angeles Museum from the asphalt deposits of Rancho La Brea furnishes undoubtedly the most complete single record of the mammalian life of the Pleistocene which has come to the attention of the palaeontologist. Distinguished alike by a remarkably perfect preservation of its materials and by a great variety of types represented, this collection affords opportunities for research such as are rarely encountered in studies relating to the life of the past.

In the progress of the investigation of this fauna it has become apparent that the representation of types or rather the relative frequency of occurrence of specific mammals in the Rancho La Brea assemblage presents some interesting facts of significance not only in an interpretation of the conditions which prevailed in and about the tar traps during the active period of miring and entombment, but also in a determination of the position and relationships of this faunal stage in the Pleistocene. An attempt is made in the present paper to survey the entire mammalian collection in the museum with a view to recording a census particularly of the larger mammals obtained from the asphalt.[2] While undoubtedly

[1] Summary of this paper presented before the National Academy of Sciences, November 21, 1928.

[2] The single record of a tapir, based on two phalanges in the collections of the University of California, is included in the census in order to complete the list of larger mammals.

a census of this kind should also take into account the smaller forms, namely the rodents, lagomorphs, insectivores and bats, the meagre representation or total absence of these types in the museum collection does not permit an extension of the survey to include these mammals at the present time. Whether or not the paucity of smaller forms is to be ascribed to the peculiar conditions under which the accumulations took place or in larger measure is due to the method of collecting may remain perhaps an open question.

In establishing the census only adult animals were in general considered and counts were made of the individuals representing each of the several groups, such as dire wolves, coyotes, sabre-tooth cats, ground sloths, mastodons, and the like, the count in each case being determined by the number of similar parts of the internal skeleton as for example the skull, right ramus of mandible, left tibia, right scaphoid. In many cases the total number of individuals for any single group is probably a minimum estimate. In the two groups of mammals having the largest representation, namely the dire wolves and the sabre-tooth cats, the total number for each group is an approximate number, although here again the estimate probably does not exceed the actual number of these forms in the collection. While further segregation of the materials may tend to modify somewhat the estimate of the total number of individuals recorded for each group, it is probable that the relative size of these groups will not be greatly affected.

GROUP REPRESENTATION IN THE MAMMALIAN FAUNA

The most striking feature of the Rancho La Brea mammalian fauna is the preponderant development of the carnivore group. In this single character the fauna differs noticeably from living and extinct assemblages dwelling under the environmental conditions of the plains or open country where the balance between carnivores and herbivores has not been materially disturbed. This peculiarity with regard to the Rancho La Brea fauna has been noted by Merriam[3] in his discussion of the mode of accumulation of the fossil remains. To quote from Dr. Merriam:

> The number of carnivores represented is entirely out of proportion to the normal number of other animals present in the fauna, and is apparently to be explained by a peculiar process of selection, which may be seen in operation about

[3] Merriam, J. C., The Fauna of Rancho La Brea, Pt. I. Occurrence. Mem. Univ. Calif., vol. 1, pp. 209–211, 1911

the tar pools at the present time. Whenever an animal of any kind is caught in the tar its struggles and cries naturally attract the attention of carnivorous mammals and birds in the immediate vicinity, and the trapped creature acts as a most efficient lure to bring these predaceous animals into the tar with it. It is not improbable that a single small bird or mammal struggling in the tar might be the means of entrapping several carnivores, which in turn would naturally serve to attract still others.

FIG. 1. DIAGRAM SHOWING RELATIVE ABUNDANCE OF INDIVIDUALS OF VARIOUS ORDERS OF MAMMALS IN THE PLEISTOCENE FAUNA OF RANCHO LA BREA

The present census reveals a total number of 4264 individuals grouped under the five orders, Carnivora, Artiodactyla, Perissodactyla, Proboscidea, and Edentata. Of this number 3890 or 91 per cent are carnivores, while the remainder or 9 per cent are herbivores. This decidedly

unbalanced numerical relationship of predatory forms to plant-feeders obviously does not express the normal mammalian population as it existed in the Los Angeles region during the Pleistocene and, as suggested by Merriam, finds its explanation in the conditions of miring and trapping that prevailed at the locus of concentration of the materials.

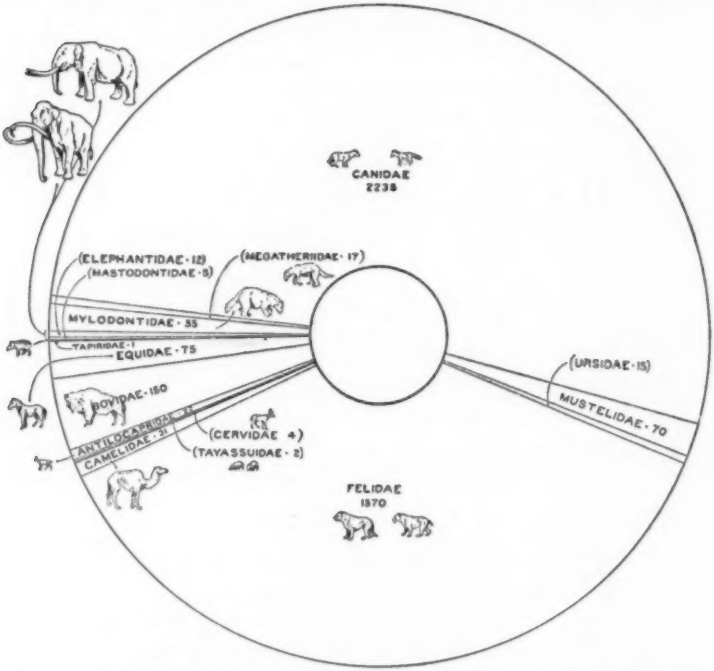


FIG. 2. DIAGRAM SHOWING RELATIVE ABUNDANCE OF INDIVIDUALS OF VARIOUS FAMILIES OF MAMMALS IN THE PLEISTOCENE FAUNA OF RANCHO LA BREA

The relative size of the various orders is expressed in the diagram shown in figure 1. Within the herbivorous group, the artiodactyls are most abundantly represented and this division of mammals is followed in the order of lesser representation by the Perissodactyla, the Edentata, and the Proboscidea.

Figure 2 illustrates the relative size of the various families of Rancho La Brea mammals. Among the Carnivora the largest number of

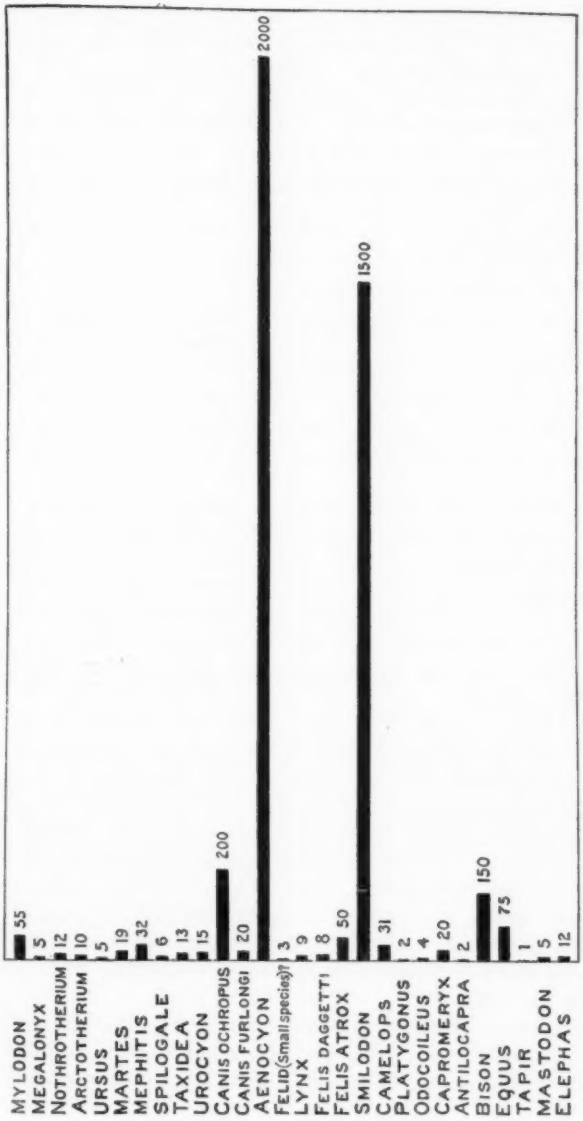


FIG. 3. DIAGRAM SHOWING NUMBER OF INDIVIDUALS RECORDED FOR GENERA AND SPECIES OF MAMMALS IN THE PLEISTOCENE FAUNA OF RANCHO LA BREA

individuals is included under the Canidae, with the Felidae forming the next largest group. The dogs constitute 57 per cent of the carnivore population, the cats 40 per cent. Each of these groups greatly overshadows in numbers the bears and mustelids. The raccoons are conspicuously absent from the fauna. Among the herbivores the largest family is the Bovidae. Then follow in turn the Equidae, Mylodontidae, Camelidae, Antilocapridae, Megatheriidae, Elephantidae, Mastodontidae, and Cervidae. Lastly come the Tayassuidae and Tapiridae, the former group having approximately the same relative importance among the artiodactyls that the latter family has among the perissodactyls, in so far as numbers of individuals are concerned.

The number of individuals recorded for each genus is shown in the diagram, figure 3. The dire wolves have the same relative importance among the canids that the sabre-tooth cats have among the felids. In each case the form greatly exceeds in numbers its relatives of the same family. Individuals of *Ænocyon* constitute 89 per cent of the canid population, while the sabre-tooth cats form 95 per cent of the felid population.

Within groups in which extinct species or genera are associated with types which range from Pleistocene to Recent, the former are always represented by a greater number of individuals. In other words, the typical Pleistocene forms in the Rancho La Brea fauna are relatively more important elements in this assemblage than those types which are characteristic of the Recent period but whose range extends also into the Pleistocene. Thus among the canids the number of dire wolves is far in excess of that of the coyotes and gray wolves. The modern gray fox, *Urocyon californicus*, is known by only fifteen individuals. Among the cats the sabre-tooth *Smilodon*, a genus now entirely extinct, is much better represented in the fauna than the large lion, *Felis atrox*. The latter, while specifically different, is still closely related to the large living cats of the Old World. Both the sabre-tooth and the lion greatly exceed in numbers the puma and the lynx. Among the Ursidae the arctotheres are twice as abundant as individuals of the modern genus *Ursus*. In the single group of ungulates where comparison can be made the same relationship is evident. Within the Antilocapridae, *Capromeryx* forms a decidedly more important group than the modern prong-horn, *Antilocapra*.

The inference may be drawn from these relationships that the relative size of the Pleistocene elements in the fauna is in a measure an index of the antiquity of the assemblage. Furthermore, it appears reasonable to

assume that were another large fauna to be recorded from a stage in the Pleistocene its age-relationship to that of Rancho La Brea might be determined on the basis of proportion of extinct types to living forms, providing of course that other factors controlling the representation of types were essentially comparable to those which prevailed at Rancho La Brea.

FURTHER FACTORS INFLUENCING THE GROUP REPRESENTATION

In addition to the factor of time the determining elements exerting an influence on the occurrence of the various groups of mammals at Rancho La Brea appear to be found in the environmental conditions which prevailed and in the habits of the animals themselves.

The environment in and near the tar traps. Undoubtedly the remarkable representation of the dire wolves and of the sabre-tooth cats is to be largely accounted for on the basis of the conditions prevailing in the immediate vicinity of the asphalt accumulations which offered habitats particularly suited to these creatures. *Ænocyon* is a heavy-headed canid with a relatively small brain and a massive dentition. The structure of the limbs and feet in this form suggests that the animal possessed to somewhat less degree the cursorial adaptations of the canid tribe. These forms may well have hunted in packs, preying upon the large, cumbersome, and slow-moving mammals with which they were associated. Their massive dentition suggests a propensity to bone-crushing and they may have fed also on carrion. It appears possible that the group in a broad way occupied a position in the Rancho La Brea Pleistocene fauna comparable to that occupied by the hyaenas in the living assemblage of South Africa. The tar traps, with their living hosts and partly devoured, dismembered carcasses, may be regarded as offering especially favorable feeding grounds for these types.

The sabre-tooth cat of the Pleistocene in contrast to the great lion seems quite certainly not to have been a predatory form depending upon its fleet-footedness in securing its prey. *Smilodon* exhibits rather an organization admirably adjusted to grappling and fighting at close quarters. This arch murderer, whose race has left a trail of blood through the Cenozoic, presents the uncanny combination of a soft paw and a stiletto. Truculent to the extreme, this creature with its relatively small brain, deadly dental battery, and powerful front extremities found its victims among the slow-moving mammals and the stationary live bait of the tar traps. The unfair advantage which the sabre-tooth cat possessed around the borders of the asphalt accumulations was apparently compensated only by its own high mortality.

The environment of the Rancho La Brea hinterland. That the country surrounding the asphalt deposits presented topographic features essentially similar to those characterizing the Los Angeles area to-day is strongly suggested by the fauna as a whole and apparently also by the geologic history of the region. The climate may have been as equable as it is to-day with, however, a somewhat greater precipitation. A plains or open rolling country supporting a richer vegetation than that of the present, in which grass-covered surfaces were interspersed with copses of trees and brush, appears to have been favorable for the development of a diverse ungulate population. In this environment would be normally found such types as the bison, the horse, mylodont ground sloths, Proboscidea, camels, antelopes and other hoofed mammals. Associated with these herbivores would occur typical cursorial carnivores like the lion and the coyote. As important members of the community should be listed the dire wolves and the sabre-tooth cats. One might regard this assemblage as representing perhaps the resident population.

In contrast to this group the sparse representation at Rancho La Brea of such types as the megalonychid ground sloths, the tapirs, peccaries, deer, mastodonts, and doubtless other forms, may be interpreted as indicating mammals that were not habitually to be found in this region but which only occasionally penetrated it from adjacent areas. In this connection it is significant to note the great number of the grazing mylodont sloths in contrast to the few individuals of the browsing, forest-dwelling megalonychids. The region seems, however, to have been sufficiently wooded or covered with brush to afford shelter to the delicate and small *Capromeryx*. It is surprising to find this beautiful creature so well represented at Rancho La Brea, associated with the large ungulates and formidable carnivores. *Capromeryx* with possibly nocturnal habits may have occupied a niche in the environment somewhat like that in which the dik-dik and duiker antelopes of South Africa are found to-day.

The total absence of members of the Procyonidae possesses some interest. While the failure to recognize the presence of raccoons is in substance negative evidence, the fact that this evidence comes from the analysis of so large an assemblage as the one occurring at Rancho La Brea makes it appear to merit consideration. That these forms were absent in the Los Angeles region during the period of entombment at Rancho La Brea seems rather unlikely. *Procyon* occurs in the Pleistocene of California and its range to-day extends into this southern area.

Possibly the extreme wariness of this mammal may account for its absence in the record. The absence of the kit fox (*Vulpes*) may be due to the presence of less arid conditions than prevail at present.

It will be noted from the above discussion that the "water-hole hypothesis" has not been invoked to account for the congregation of types at Rancho La Brea. While springs, ponds, and some flowing water may well have been present in the immediate vicinity of the asphalt beds, it seems also probable that at no great distance were streams, as for example the predecessor of the present Los Angeles River, which even during the driest seasons may have had a sufficient flow of water to sustain the animal life of the region. In other words, it would appear unnecessary to assume, because of the large assemblage recorded at Rancho La Brea, that the surrounding area during this stage of the Pleistocene was as devoid of water as are the drier portions of the African veldt at the present time.

CONCLUSION

The scene at Rancho La Brea, as visualized from a study of the Pleistocene mammalian life of this time and place, possessed on occasion apparently a sombreness deepened by dramatic significance. These tar traps during their active periods appear verily to have been ulcerous spots on the face of Nature, where death mocked the comparative serenity of life in the open.

Within the borders of the pools where the petroliferous ooze exerted a peculiarly tenacious grip on the victims, there doubtless could be seen at times a curious array of mired hosts pitted against a common adversity. Immediately without the confines of the trap the unwelcome flesh-eater lent his presence as a dominant participant in the drama, truculently watchful of the prey so near at hand, yet wholly unmindful of the end destined to overtake both fellow and foe alike. The cries and struggles of the wounded, the not infrequent stench of offal, and the fierce combats of those not yet mired may well have made of the individual trap a quagmire whose horrors and iniquities are now veiled with the inevitable passing of geologic time.

Los Angeles Museum, Los Angeles, California.

SNOWSHOES IN WINTER

By Tappan Gregory

[*Plates 20–21*]

It was not really winter, I suppose, in the most exact sense of the word, when I obtained the accompanying pictures, but with several feet of snow on the ground, the lakes frozen solid, and the temperature averaging around 20°F. the whole aspect of the country was such that I always think of the trip as a winter expedition. Snow was falling heavily when we drove in from Marquette, Michigan, to our destination in Marquette County on March 9, 1928. My brother was with me and Carter H. Harrison, Jr., and Ralph S. Davis. I like to mention my associates on these trips because so frequently their coöperation contributes in no small measure to the successful operation of the trap camera.

Scanning the snow for signs of wild life, I was impressed with the fact that tracks of the varying hare were much more numerous than they had been during the preceding November, and those of the red squirrel not so much in evidence. It was several days after our arrival, however, before we set the camera for the snowshoe rabbit. I entertained delusions of possible fox pictures and with that in view, spent one splendid, but rather arduous, day carrying the apparatus through the soft snow. A careful survey of a frozen beaver pond, now white with new fallen snow, still and lifeless, and of the surrounding forest, revealed only the tracks of deer and rabbits, and one stale fox trail. Nearer home fresh fox tracks encouraged us. They seemed intimately associated with the den which we knew to be hidden away among the jack pines, but the day was so far gone that we thought it advisable to make a set at random, using as bait a dead bird sprinkled with a few drops of scent bait.

Extensive reconnaissance was discouraged on the eleventh because rising mercury made the going quite heavy. Fresh skunk tracks (pl. 20, fig. 1) appeared that day and in one place we found a bit of skunk fur in the road, suggesting by its appearance the fantastic idea that it had frozen in as the animal sat still and pulled out when its owner moved on. We traveled enough to find the fox den about one-hundred and fifty feet from the camera. It was plainly occupied, and close to its mouth were two large bones well chewed. Returning along the bank of Pine River, we crossed more fox trails. Some of the tracks

led on to the ice of the river and the melting snow left them in places looking like a series of miniature extinct volcanoes, for the snow melted more slowly where it had been packed by the tread of the fox, and these spots stood above the ice when the snow about them had sunk away under the influence of the high temperature. I think that was the warmest day encountered, as the temperature went to 41°F., though it was much cooler again after dark when more snow fell. There had been no change in the camera that morning and during the rest of our stay we saw no more fresh fox tracks in that locality. I thought from the signs that the fox had been at its den after the camera had been set. Apparently, our snowshoe tracks in the vicinity did not make it seriously apprehensive, but once they had appeared in close proximity to the den, it took immediate alarm and moved away. I tried in vain to lure it back with mice left from time to time by the den.

The wail of a coyote awakened us soon after six on the morning of March 12, to find the promise of more snow, with a temperature somewhat below freezing. We saw no game that day except one rabbit in a nearby cedar swamp. Quite a bit of gray was already showing on this individual, particularly on the ears below their tips. More snow fell thickly in the afternoon, with snow and rain all that night, especially rain. A fine rain continued a good part of the next day, but the temperature, which started out at 36°F., fell steadily and though patches of blue sky showed through the clouds late in the afternoon, by supper time it was again snowing. A skunk had found a piece of meat that I had thrown down by the fox den, and in general the prospects of fox pictures there were so remote that we picked up the camera and after searching in vain for another den, the whereabouts of which had been known to us some years before, set it for rabbits among the jack pines, close enough to our cabin so that we might sometimes hear the flash. The tracks there were not very fresh, but they indicated that there had been some considerable travel not long before, making a species of what might be called a runway. We baited with a little wad of peanut butter impaled on my favorite copper wire trip, with oatmeal sprinkled about, and a carrot left on the runway several feet away.

March 14 brought us a combination of high wind, sunshine and snow, with a temperature of 20°F., but no results at the camera. A rabbit had passed several feet behind it. Alternating sun, shadow and snow flurries continued all day, and the delicate tints on the clouds at sundown were very effective. When twilight came, the pale greenish blue light in the west made the snow look purple. These must have

been favorable signs, for no day could have been more perfect than the fifteenth; from daylight until dark not a cloud was visible in the sky, followed by a night clear and brilliant, though without a moon as that had waned past the last quarter. The temperature hardly varied a degree from 20°F., and the breeze was brisk from the northwest. The trap was found sprung that morning and there were deer tracks on the side of the bait opposite the camera, with sufficient disturbance of the snow to indicate plainly that the deer had jumped. But the appearance of the peanut butter, broken away from the wire and lying in pieces on the ground, and fresh rabbit tracks at the bait, left the question of the subject in doubt. Actually, the deer nosing the peanut butter had taken the picture (pl. 20, fig. 3), and the rabbit must have come later.

After developing this picture of the deer, we scouted slowly back to Mountain Lake, which lies something over a mile south of Pine Lake, connected by picturesque Mountain Stream. There was sufficient snow on the ice of these lakes to necessitate the use of snowshoes for comfortable travel in the crossings. On Pine Lake we found half a dozen trails made by coyotes, as well as we could judge, though they were old enough to be somewhat difficult of identification. All but one headed in the same direction. Climbing the hill after leaving the south shore of Pine Lake, we noticed fresh fox tracks crossing and paralleling our path, and farther along came upon a veritable mouse playground, many tracks (pl. 20, fig. 2) crossing and recrossing each other, made by red-backed mice (*Clethrionomys*), if we read them rightly. Near the bridge over Mountain Stream, close to Mountain Lake, a mink had left the stream, skipped across the road and turned back to the river again, several hundred yards below. The stream was open, of course, down through the gorge, except for a few places near shore where the water was quiet and the current had also kept it open where it flowed under the bridge. Here we saw many poplar and birch cut by beaver in the last day or so, two or three slides into the stream, chips on the snow, and tracks covered only by the light fall of the day before. A partridge also left a visible trail, the only sign of one that we saw on our trip. Tracks of rabbits, squirrels, deer and skunks showed up in more or less abundance, and those of at least one porcupine and some also of *Peromyscus*.

It was after five-thirty that afternoon before the trap was recharged and baited again with peanut butter and oatmeal. Something set it off at nine o'clock and the next morning we found the butter gone, consider-

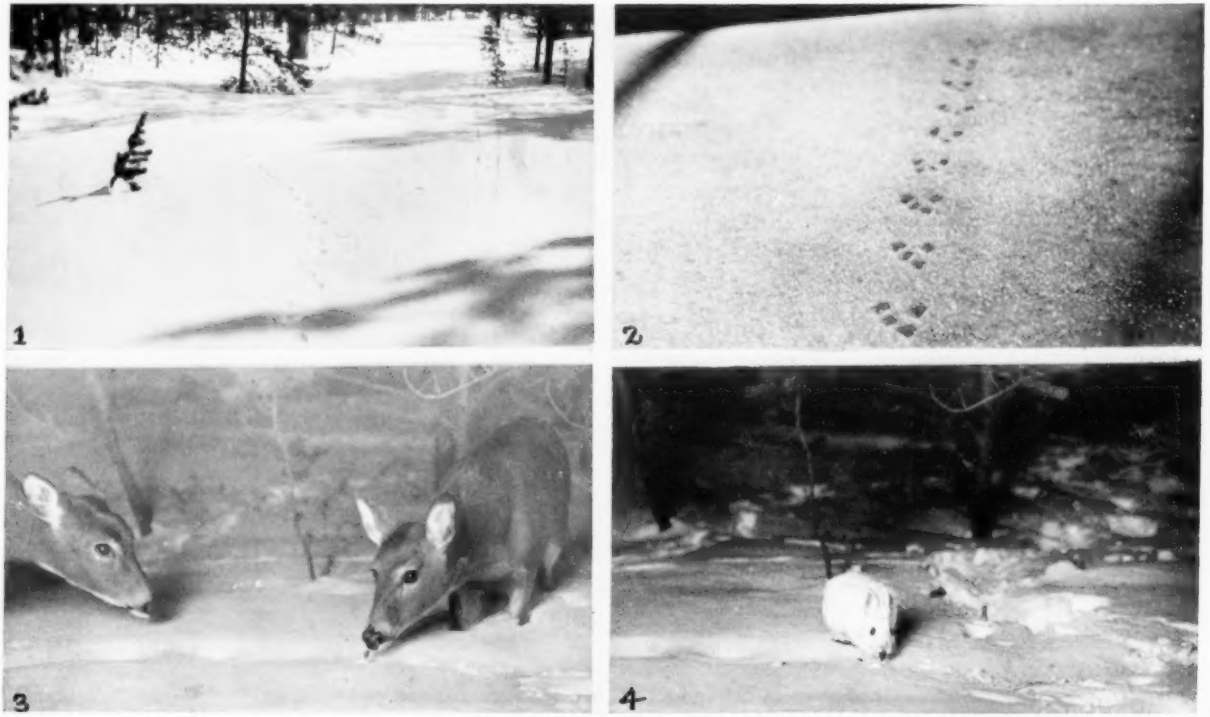
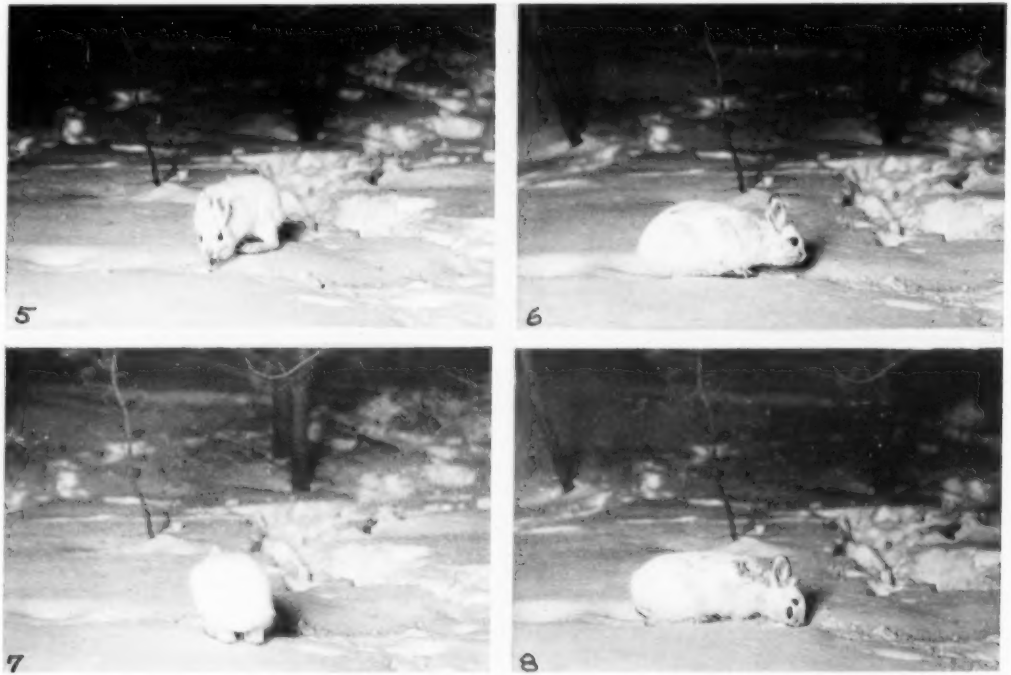


FIG. 1. TYPICAL SKUNK TRACKS. FIG. 2. MOUSE TRACKS IN THE SNOW. FIG. 3. DEER NOSING PEANUT-BUTTER BAIT.
FIG. 4. SNOWSHOE RABBIT AT PEANUT-BUTTER BAIT, MARCH 15, 1928



SNOWSHOE RABBITS

FIG. 5. FIRST PICTURE OF MARCH 16, 1928. SNOW DISTURBED BY DEER. FIG. 6. SECOND PICTURE OF MARCH 16. FIG. 7. THIRD PICTURE OF MARCH 16. FIG. 8. FOURTH PICTURE OF MARCH 16

able oatmeal eaten and fresh rabbit tracks. The picture turned out to be of a rabbit (pl. 20, fig. 4) facing the camera and the flash had gone off at the first light touch on the bait, pointing strongly to the conclusion that the rabbit either finished its meal on the spot, or returned for that purpose before we came. This was true of every picture we took, as far as we could tell from inspection.

The night of March 16 was our last one in the woods and we were kept busy. There was no material change in the temperature, the mercury remaining several degrees below freezing. At sundown the ice, piled up along the shore of Lake Superior some distance out on the lake, took on a delicate lavender hue and from time to time could be heard muttering and grinding. The camera had been set again at a quarter past five and at six twenty-five, coming outdoors after supper, we heard the flash (pl. 21, fig. 5). When we picked up the negative at six-thirty, it was still quite light because of the snow on the ground and the twilight. It seemed worth while to keep the trap set, so we rebaited it and by six fifty-four left it again in order. Four minutes later, on our way to our cabin, we saw and heard the flash once more (pl. 21, fig. 6). I delayed returning in order to check up on the apparatus by developing the first of these two pictures, and did not return until seven forty-five, leaving the set again at about ten minutes past eight. Really it was to me an impressive night, very still and clear, the stars brilliant, Orion well down in the west already, the Big Dipper standing on the end of its handle pointing faithfully toward the North Star, and the ice on the big lake now steadily rumbling and booming. I made another trip to the camera after developing the second picture just to make sure that everything was all right and found at nine-thirty that there had been no further visit from the rabbit. But five minutes later I saw and heard the flash again (pl. 21, fig. 7). It took only ten or fifteen minutes to recharge and reload and that was the last shot that we were sure of that night. I was up early the next morning in response to the cry of a distant coyote, to find the trap sprung and as usual the peanut butter gone. This time the picture (pl. 21, fig. 8) showed that the rabbit started on the oatmeal and hit the trip wire quite by accident. It was much colder in the early hours, the temperature standing at zero when I went out, and the heavy frost on the jack pines sparkling in the early morning sun made a striking picture.

Chicago, Illinois.

FURTHER NOTES ON THE MAMMALS OF NORTHERN RHODESIA AND PORTUGUESE EAST AFRICA

By Wynant Davis Hubbard

WART-HOG

Wart-hogs are among the very few African mammals that drink during the heat of day. Early in the morning and from four o'clock on in the afternoon they root and feed. But contrary to the habits of most game, wart-hogs chose the hottest time of day for wallowing and drinking. During the course of a year (April, 1924, to March, 1925) that we spent traveling from Shamva, Southern Rhodesia, to Tete, Portuguese East Africa, and on up the Zambesi to the Luia and Cafuchi rivers, my native hunters and myself shot and captured thirty wart-hogs of all ages and both sexes.

The records that I kept show the following facts. Of seventeen sows shot eight were in farrow. All but one carried four fetuses. The exception, which was a very old sow, carried only two. On August 13 and 14 sows were shot that carried fetuses only very slightly advanced. In October one was shot where fetuses were very well developed and fully formed. On November 30 I caught two of four shoats that were running with a large fully adult sow. These measured seven inches high at the shoulder. These records would indicate that wart-hogs breed sometimes early in July or late in June and that the young are born late in October or early in November. However, my records show a sow carrying well developed fetuses August 8, and one in September with very slightly developed embryos. Evidently the seasons of wart-hogs are not so well defined as those of the antelopes and zebras.

Although it is not an uncommon event to find single individuals (usually mature boars), wart-hogs usually roam the veldt in herds numbering up to six adults. The herds may number more but I have never counted more. Lions, leopards, and wild dogs prey constantly on wart-hogs, but I doubt if the wild dogs kill a great number, owing to the wart-hog's habit of running to, and hiding in, ant-bear holes. Wart-hogs run long distances at surprising speed. I have chased them with dogs for over two miles at top speed. Almost without exception the chases ended by the wart-hog going to ground. When pursued by wild dogs the wart-hogs undoubtedly follow the same procedure.

My records show tusk measurements by steel tape, in inches along the outer curve, as follows: Boars—9.5, 7.5, and 7.5; sows—5.75, 6.75, 7.25, 6.75, 6.5, 4.25, and 6.75.

My records regarding wart-hogs show the following facts:

1. They are very numerous wherever there is water and where the ground is not swampy. It is an exceptional day's hunt that does not turn up at least one herd of wart-hogs.

2. Wart-hogs habitually drink and wallow between ten-thirty and three, although they may be found doing so at any time.

3. They run fast and far, and can climb steep banks and rocky hills. Their final protection is refuge in ant-bear holes, a protection which they will seek at the first opportunity by sliding into the hole backwards.

4. The sows usually throw litters of four. These are born in November, but variations occur.

5. Wart-hogs root with the upper tusks and the snout. The lower tusks, which are very sharp, are for defense and cutting.

6. Lions and leopards kill many, but wild dogs are probably not so successful because of the wart-hog's habit of going to ground.

7. Where preference is offered wart-hogs will drink at a pan rather than at a river.

BUFFALO

During the year under consideration only six buffaloes were shot. The Zambesi Valley, on the north bank in the region between Tete and Chiputo, is not a good buffalo country. The ground is stony, and steep small hills abound. Of the six buffaloes, five were bulls and one a cow. The two largest bulls' horns measured 43 and 41.5 inches between points. The cow was shot on November 15. It was very fat and carried a fetus that was about two-thirds developed.

Buffaloes feed at night, and drink early in the evening and early in the morning. After their last drink they travel slowly back into the veldt and lie down during the heat of the day. Depending on the amount of hunting to which they are subjected, they may lie down in dense thickets or in open mopani bush, or they may wallow in mud pans.

Buffaloes have acquired a tremendous reputation as man-killers. To my mind it is a reputation not wholly justified. When wounded or cornered, they will charge with an abandon approached by no animal save the leopard. But when unmolested buffaloes are harmless. They can be tamed and made to work. Most important of all they do not charge in herds. There have been many accounts published of such charges "en masse." But those who have hunted buffaloes and studied them agree that these so-called herd charges are nothing more than attempts to escape by back tracking.

In the Mashahulumbwe country of the Kafue River district, and in the country north and west, nearly every buffalo-herd spoor that I studied had mixed with it the spoor of lions. This part of Northern Rhodesia is inhabited by many lions. Whether or not they kill many buffaloes is questionable. Those that I have shot have borne no marks of encounters with lions and I doubt very much if a lion can kill a full-grown buffalo. They must, however, kill calves and aged animals, or they would not follow the herds so persistently.

Buffaloes are found only locally. They require water, mud and plenty of grass. Most often they frequent the banks of rivers or large stretches of long grass such as the Kafue Flats.

HIPPOPOTAMUS

I shot a cow hippopotamus on September 24 that carried a fetus five inches long. The embryo was perfectly formed in every exterior detail. Most unfortunately I did not have spirits in which to preserve it, nor scales with which to weigh it. Two years previously I shot a hippo in the Kafue River in early August. This carried a fetus that was twenty-seven inches long. It would have been born very shortly, probably within two weeks.

There is no sport whatever in shooting hippopotamuses. The hide, when cut into strips four and one-half inches wide and carefully dried, becomes as hard as wood. Thus prepared it has a market value of roughly a shilling a pound. The strips of hide are made into canes and shamboks (whips). The fat also makes very acceptable lard and sells for the same price as the hide. When properly prepared a hippopotamus can be converted into a cash value of more than a hundred dollars. Considering that there is no risk attached to the hunting, it is not surprising that hippopotamuses form one of the lucrative bags of the "skin-hunter."

The Kafue and Zambesi River hippos eat only grass. The berries and roots that tempt their big confreres, the elephant and rhino, make no appeal to them.

If undisturbed hippos spend much of the warm daylight lying on sand-bars. During the early part of the night they feed. On the high plateau hippos return to the water between two and three in the morning, probably because of the cold. They can swim so fast that a canoe could not be handled with any certainty of following them. On the lower Zambesi, hippos habitually swim the length of the tortuous and swift Quebarabasa Rapids. On occasions they travel twenty or more

miles overland between rivers or lagoons. They are at home in every way in water, but they prefer the land when no danger threatens.

HYENA

Four hyenas were trapped, all on the Luia River in Portuguese East Africa. Three of these were dogs. The fourth, a bitch caught August 20, was in milk. Both glands were full and contained a cup of recoverable milk. In Northern Rhodesia hyenas are quite common, but around the ranches and near the railroad they have been killed off thoroughly by poison.

Hyenas are tremendous travelers. Their big dog-like tracks abound along all paths and trails. A very good indication of the number of hyenas in any particular district is the number of droppings. These are easily recognized as they are dead white in color and very large.

It is rare that hyenas kill game. They sometimes do so, but they infinitely prefer bones or carrion. In fact no carnivore familiar to me in Africa will pass by carrion. I have had crocodiles travel more than a mile following the scent of tainted bait. Such bait is as good as live bait as an inducement for lions, leopards or cheetahs to enter a trap. Wild dogs probably eat more game that they kill themselves than any of the other predatory animals.

New York City.

NOTES ON THE LIFE HISTORY OF THE KANGAROO MOUSE (MICRODIPODOPS)

By E. Raymond Hall and Jean M. Linsdale

[*Plate 22*]

The kangaroo mouse, or dwarf kangaroo rat as it was initially designated, was obtained first in the fall of 1890 by Vernon Bailey, in Nevada, at Halleck and in the Reese River valley. The following year it was made known to science (N. A. Fauna, no. 5, p. 116) by Dr. C. Hart Merriam under the name *Microdipodops megacephalus* and was pronounced by him "one of the most remarkable of the many new and interesting mammals that have been discovered in North America during the past few years. . . . . " Despite their desirability, specimens since then have been slow in accumulating. Also, little has been learned regarding the habits of kangaroo mice. Accordingly, when the writers, in June, 1927, were located at the fossil beds seven miles north of Arlemont, in Fish Lake Valley, Nevada, where Miss Annie M. Alexander had two years before obtained one of these animals, the opportunity was taken to learn more about them. Certain information contained in the field notebooks on file in the California Museum of Vertebrate Zoology has been used. Acknowledgment is here made to Paul G. Redington and to Maj. E. A. Goldman of the U. S. Bureau of Biological Survey for permission to use, in the present account, the notes procured by one of us (Hall) largely in 1925 while in the employ of the Bureau in Nevada.

Kangaroo mice have been taken at the thirteen localities listed in the accompanying table and at the following additional localities, all in the Great Basin region: Four miles southeast of Coaldale, 4850 feet, Esmeralda County, Fernley, 4200 feet, Lyon County, and Winnemucca, 4300 feet, Humboldt County, Nevada; Vinton, 4900 feet, Plumas County and two miles east of Eagleville, 4700 feet, Modoc County, California; Lake Alvord, Malheur County, Oregon. All these places are in the Upper Sonoran Life Zone and they are at altitudes ranging from 4000 to 6600 feet.

Type of soil appears to be a factor important in determining the local distribution of kangaroo mice. Knowledge of conditions at seventeen places where specimens of this mouse have been collected shows that, at all but one, the animals were either wholly confined to, or were most abundant in, fine loose sand. The exception was a place

thirty-three miles south of Austin in Reese River valley. There, the soil was coarse and so uniformly mixed with sharp-edged gravel that the kangaroo mice would, in digging burrows, certainly have to excavate pieces of gravel nearly one-fourth of an inch in diameter. All field notes, relative to *Microdipodops*, on file in the Museum of Vertebrate Zoology state that specimens were taken in sandy soil. Naturally, this strong predilection for loose sand results in spotted distribution in areas where the type of soil varies markedly. In Fish Lake Valley, seven miles north of Arlemont, Nevada, where soils of widely varying nature occur in an area of less than one square mile, we secured one hundred and seventeen specimens of the kangaroo mouse. The animals were found in greatest numbers in the finest sand. This was slightly drifted and supported a fair stand of desert shrubs. The sand was so fine that a person sank two or more inches in walking over it and the kangaroo mice left well defined tracks. The animals were found in lesser numbers where the sand was so coarse and so closely packed that a person's tracks on it were barely discernible.

However, type of sand, alone, appears not to be sufficient to determine the presence of *Microdipodops*. In Clayton Valley, Nevada, at the type locality of *Microdipodops megacephalus lucidus*, sand dunes of many rods in extent are absolutely devoid of vegetation. A marginal strip of equally fine sand is drifted among desert shrubs and other flowering plants which in spring bloom and mature their seeds in a short period of time. Still farther from the dunes there is coarser sand supporting similar vegetation. On June 25, 1928, one hundred and sixty traps, about equally divided between these three types of habitat, yielded thirteen specimens of the kangaroo mouse, each taken on the fine sand within fifty feet of some shrub. In addition to our trap record, careful search, in early morning before the wind had risen, for tracks in each of these three types of habitat bore out the fact that this animal frequented neither the coarse sand with vegetation nor the fine sand without vegetation, but only that strip of fine sand with vegetation. Thus, in so far as our information at this place goes, the kangaroo mouse, although restricted to fine sand, is further restricted in that plants must be present.

The same trap lines, seven miles north of Arlemont, which caught *Microdipodops megacephalus dickeyi* also caught three species of *Dipodomys*, including the large *deserti*, *Perognathus parvus* (in slightly firmer soils), and *Perognathus nevadensis* (chiefly in the coarser soils).

Among the more conspicuous plants in the same habitats in Fish

Lake Valley as the kangaroo mouse were the following: *Tetradymia comosa* Gray, *Parosela polyadenia* (Torr.) Heller, *Eurotia lanata* (Pursh) Moq., *Oryzopsis hymenoides* (Roem. and Schult.) Ricker, *Sarcobatus vermiculatus* (Hook.) Torr., and *Gilia* sp.

In the case of most of the trap lines that were run, seven miles north of Arlemont in Fish Lake Valley, Esmeralda County, Nevada, kangaroo mice were sufficiently numerous for two nights of profitable trapping. A third night's trapping in one place usually produced little. When the traps were set twenty feet apart, individuals were in several instances caught in three consecutive traps or in the same trap on two nights. It is worth noting that at this same locality in the summer of 1928, 201 traps set for one night at regularly spaced intervals in an area 96 by 30 feet yielded only four kangaroo mice and three other mice. Search over the surface of the sand on the following morning revealed few tracks that might have been made by these animals. Apparently the kangaroo mouse population at that place in 1928 was much smaller than in 1927. We infer that in the elapsed time of one year invasion of this territory had not brought the population to its former numbers.

These mice are nocturnal. One that we kept alive in Fish Lake Valley in a small box moved about some during the day but became more active about 8 p.m. At this place, on the night of June 5, we visited a freshly baited line of 125 mouse traps at 9 p.m., and found four kangaroo mice. Seven and one-half hours later, at 4:30 a.m., twenty-two more were found in the traps. Thus, at this place early in June, the animals become active at 8 p.m., or shortly thereafter.

Tracks of kangaroo mice may be described as miniatures of those of kangaroo rats. The relatively large impressions of the hind feet usually are not parallel but have the toes pointing outward. This position permits the hind feet, equipped as they are with stiff, projecting hairs on the sides of the soles, to function as "sand-paddles" much after the manner of those of the whip-tailed lizard (*Cnemidophorus*), except that the two feet are used at the same time rather than alternately as in *Cnemidophorus*. Thus the tracks of the two hind feet are opposite, rather than alternate to one another. Impressions of the fore feet usually are present. When impressions of the fore feet are absent, consecutive tracks of the hind feet are farther apart than otherwise. This indicates that rapid progress is accomplished mainly or wholly by use of the hind feet. Further evidence for this assumption is furnished by the fact that the tail mark is faint or absent when the consecutive tracks of the hind feet are far apart and the tracks of the fore feet absent.

Of the tracks of other animals living in the same areas with kangaroo mice, those of the pocket mouse (*Perognathus parvus*) are most likely to be confused with those of the kangaroo mice but may be distinguished in that tracks of the pocket mouse nearly always have the impressions of the fore feet and the anterior parts of the tracks of the hind feet narrower. One young kangaroo mouse at Halleck, repeatedly jumped out of a can the sides of which were seventeen inches high. This it did without touching the sides of the can although it was only ten inches in diameter.

In situations protected from the wind we have found well defined trails believed to have been made by kangaroo mice. Tracks of the mice show that they do much wandering during the night. The home range appears to be extensive for so small an animal. As shown by tracks, at Halleck, the home range, in one case at least extended seventy yards. Tracks led across open places of several yards in extent as well as under and around bushes and showed that stops had been made at frequent intervals regardless of the presence or absence of cover. At many of the stopping places, slight excavations were made in the sand, presumably in quest of seeds or other food. The burrows found by us were without nests and we think they represented resting places for the animals during the day. At Oasis, California, one open burrow was found with tracks leading from it directly to a trapped animal two feet away. The mouth of the burrow measured one inch vertically and three-fourths of an inch horizontally. The burrow was straight, six inches long and ended four and one-half inches below the surface of the ground. There was no nest or even enlarged cavity at its end.

Live animals in traps sometimes, when handled, give voice to sharp squeaks. Otherwise we have no record of their producing vocal sounds. They avoid the light, as was shown by individuals liberated in daytime which almost invariably turned away from it. This would be expected from the appearance of their eyes, which are large and black and strongly suggest a nocturnal adaptation. Other noteworthy adaptive features are the greatly lengthened hind feet and lower legs, and the stiff projecting hairs that occur on the sides of the hind feet. Strangely enough, the tail, although long, is tapering and without the terminal tuft commonly found in jumping mice and rats, for instance in *Dipodomys*, *Dipus* and *Gerbillus*. Most noteworthy of all, perhaps, are the greatly inflated auditory bullae which reach their maximum relative size in kangaroo mice.

The food of this animal probably consists mostly of seeds. In Fish

Lake Valley, seeds of *Gilia* sp. and *Oryzopsis hymenoides* were found in cheek pouches. The cheek pouch of one individual from this valley contained a larva, three-fourths of an inch long, of an insect. The fore feet are brought into play in eating some foods. A mouse kept alive for a few hours at Halleck, Nevada, held flakes of rolled oats between its fore feet when eating, but made no use of the paws in eating the much finer cornmeal. Another mouse used its fore feet when feeding, both to pull pieces of stems toward it and to hold seeds. The hands moved so rapidly that it was difficult to follow them with the eye.

A kangaroo mouse was caught in Fish Lake Valley on June 4, 1927. It was kept alive until it died on December 5, 1927. For four days after it was captured the mouse was active in the daytime and especially so after dark when it jumped almost continuously in an effort to escape. Later it was less restless and kept quiet in the daytime.

This captive animal displayed a decided preferential choice for certain kinds of seeds. For example, it selected certain grass seeds and ignored the rolled oats when both were present. It seems reasonable to suppose that a similar preference for certain kinds of seeds might be exhibited by these mice in their natural surroundings. When offered a beetle the mouse readily took it and ate it.

To judge from the arid character of places where specimens have been taken, it seems improbable that the kangaroo mice need a regularly available supply of water. Furthermore, the individual kept in captivity for six months was given no water or even succulent food.

Only once, did the mouse offer to bite and then it appeared to be attempting to escape from a strong light. Then, it was unable to bite through the skin of the palm of the hand. When several kangaroo mice were placed in a cage together they apparently paid no attention to one another. However, one that was kept for a short time with a small pocket mouse (*Perognathus nevadensis*) bit the pocket mouse on the head and back.

The most noticeable feature of the behavior of the captive mouse was its marked desire to evade strong light. In the daytime it rarely came out of the darkened box, installed in its wire cage, and when it did, it chose to be in shadow whenever possible. It appeared to pay little attention to strange sounds although a quick movement, outside the cage, sent it hurrying for cover.

The captive mouse invariably kept the entrance to its small nest box, in the cage, closed with sand during the day. This, together with the fact that we failed to find burrows open during the day that

TABLE 1

Number of specimens, number of pregnant females, and number of embryos of Microdipodops found at several localities

PLACE	ALTITUDE	DATE	NUMBER OF MALES	NUMBER OF FEMALES	NUMBER OF FEMALES WITH EMBRYOS	EMBRYOS		
						Mean	Minimum	Maximum
	feet							
4–7½ mi. W. Fallon, Churchill Co., Nevada	4,000	May 11–14, 1925	3	2	2	3.0	1	6
Mountain Well, 10 mi. E. Stillwater, Churchill Co., Nevada	5,400	May 15–18, 1925	8	10	5			
Reese River Valley, Nye Co., 33 mi. S. Austin, Nevada		May 19–23, 1925	3	5	2	5.0	4	6
7 mi. N. Arlemont, Fish Lake Valley, Esmeralda Co., Nevada	5,500	May 27–June 8, 1927	50	52	22	4.4	3	6
Mouth, Little High Rock Canyon, Washoe Co., Nevada	5,000	May 30–June 7, 1920	8	5	3	3.7	3	4
Near Dyer, Fish Lake Valley, Esmeralda Co., Nevada	4,850–5,050	June 4–8, 1928	16	14				
Oasis, Mono Co., California	5,000	June 16, 1927	4	5				
Salmon Ranch, Mono Lake, Mono Co., California	6,600	June 20, 1916	3	1				
8 mi. SE. Blair, Esmeralda Co., Nevada	4,500	June 26, 1928	6	7	1	2.0	2	2
7 mi. N. Observation Peak, Lassen Co., California	5,300	July 5–10, 1925	5	8	2	2.5	2	3
2 mi. S. Benton, Mono Co., California	5,200	July 10–12, 1912	5	5				
23 mi. N. Reno, Washoe Co., Nevada	4,300	July 17, 1924	3	4				
2 mi. S. Halleck, Elko Co., Nevada		July 31–Aug. 8, 1925	2?	3?				
Benton, Mono Co., California	5,300–6,600	Aug. 28–Sept. 21, 1917	23	22				
Finger Rock Wash., Stewart Valley, Mineral Co., Nevada	5,400	Sept. 28–Oct. 2, 1925	23	11				
Reese River Valley, Nye Co., 33 mi. S. Austin, Nevada		Oct. 22–25, 1925	7	3				
Summary	4,000–6,600	May 11–Oct. 25	169	158	37	4.0	1	6

were occupied, suggests that the mice regularly close the entrances to their burrows on entering them in the morning.

Feces or places where urine was voided never were noted. Some droppings sifted from the sand on the floor of the cage occupied by the captive mouse measure from three to four and one-half millimeters in length and from one and one-half to two millimeters in thickness. They are elliptical in lateral outline and, as compared with the droppings of *Peromyscus* and *Microtus*, are wide relative to their lengths. They are of the same general shape as those of kangaroo rats.

We have especially looked for lice or fleas on kangaroo mice handled by us without finding any. One specimen taken in Reese River valley had a large tick, with abdomen distended, attached to the head between the ears. Another specimen taken at this place lacked hair over most of its back.

Most of the young are born in May and June (see table 1). One pregnant female was taken on July 5, in Lassen County, California. The smallest young found to be active above ground was a half-grown female (weight 8.5 grams) taken in Fish Lake Valley. Embryos 22 millimeters long (measured from tip of nose to root of tail without straightening the body) were found. This indicates the young to be relatively large at time of birth. The number of young in a litter ranges from one to six. In thirty-six pregnant females the average number was four.

At least twenty-two of the thirty-three adult females taken in Fish Lake Valley contained embryos. At the same time we took several young specimens, one-half grown or slightly larger. This suggests that more than one litter each year are brought forth, but we have no actual proof that such is the case.

The average weights and measurements, with minima and maxima in parentheses, of forty-one adult males and thirty-three adult females from a point seven miles north of Arlemont, in Fish Lake Valley, Nevada, are as follows:

Weight: Males, 14.3 (12.4–16.1) grams; females, 17.4 (12.6–23.6); females with embryos, 18.4 (13.9–23.6); females without embryos, 16.0 (12.6–18.7).

Total length: Males, 161 (152–174) millimeters; females, 159 (148–171).

Length of tail vertebrae: Males, 89 (80–96); females, 87 (74–97).

Length of hind foot: Males, 26.5 (24–28); females, 26.3 (24–28).

It may be noted that even the nonpregnant females average heavier

FIG. 1

FIG. 2

FIG. 1. LIVE ADULT KANGAROO MOUSE (MICRODIPODOPS MEGACEPHALUS DICKEYI)

Note the large eye, small pinna of ear, long hind foot and long non-penicillate tail. Photograph taken June 14, 1927, by J. Dixon.

FIG. 2. TYPICAL HABITAT OF KANGAROO MOUSE

Fine, wind-blown sand with xerophytic shrubs, seven miles north of Arlemont, Esmeralda County, Nevada. Photograph taken June 4, 1927, by Miss Annie M. Alexander.

than the males although in total length and length of tail vertebrae the females average smaller. Weight of the body in the males of this species is not highly variable; for the computed standard deviation for this series is .95 ± 0.07 grams, and the coefficient of variability is only 6.64 per cent.

Of all the mammals of the Great Basin region, probably none is of less economic importance, or of less potential economic importance, than the kangaroo mice. They live largely on seeds and constitute no beneficial or detrimental factor appreciable to us on range land. They seemingly do not thrive on cultivated land.

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THE MOLE CLAVICLE

By Albert D. Kistin

Despite its peculiarities the clavicle of the mole has been regarded as a modification of a normal mammalian clavicle. Thus, Dobson, in his "Monograph of the Insectivores" (1882–1889), takes it for granted that he is dealing with a clavicle. Vialleton, in his "Morphologie Générale" (1924), however, maintains that what has hitherto been called a clavicle is in reality a coracoid. Vialleton's view was called to my attention by Prof. W. K. Gregory. With his very kind criticism and suggestions I have prepared this refutation of that view.

The peculiarities of the clavicle in the mole are readily accounted for when they are considered as extremely fossorial adaptations. Before considering Vialleton's view, it is best to show that these peculiarities may be directly correlated with the digging habit, and that their derivation from the normal condition involves no difficulty whatsoever. Foremost among these digging modifications, the clavicle forms an articulation with the humerus (figs. 2, 5). It is also a very short and massive bone in contrast to the normally long and thin clavicle, and, carried forward on a very much elongated manubrium sterni, it has come to lie much more anterior than does the normal clavicle (fig. 5).

The humero-clavicular articulation may be correlated with the fact that digging involves great lateral stresses. The clavicle, butted against the sternum, is in an ideal position to withstand these stresses, and it is not surprising that the humerus forms this new joint. The

normal humerus and clavicle are very near together (fig. 1), and it requires only a slight anterior displacement of the proximal end of the humerus for it to come against the clavicle. In the natural position the mole's limb is stretched out to the side of the transverse plane of the body with the palm of the hand facing backward. Now, the relations of humerus to clavicle in the mole are in total agreement with the view that the humero-clavicular joint was formed when a normal humerus stretched out to the side for digging, as is that of the mole, was anteriorly displaced. Below the facet on the humerus that articulates with the clavicle there is a groove which separates it from another tuberosity (fig. 2). Through this groove passes the tendon of the biceps, and directly behind the articular facet is the original head of the humerus

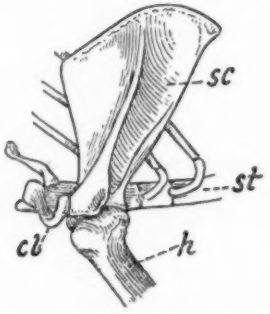

FIG. 1. PECTORAL GIRDLE OF PHALANGISTA TO SHOW THE PROXIMITY OF THE NORMAL HUMERUS AND CLAVICLE

cl, clavicle; *h*, humerus; *sc*, scapula; *st*, sternum

articulating with the scapula. The articular facet is thus undoubtedly on the external tuberosity, directly below which is the internal tuberosity. It is evident that these are precisely the relations that would be expected if a normal humerus were brought up in the position of that of the mole, and if then an articulation with the clavicle were made. For then the external tuberosity would be directly above the internal tuberosity (fig. 2), and being nearest to the clavicle the external tuberosity would be the part of the humerus to articulate. The enlargement of the articular facet on the external tuberosity and the reduction of the head of the humerus which takes place in the mole are to be expected since the humero-clavicular joint is here the important one. If the dorsal edge of the mole humerus is now examined

it will be seen that it is simply the original lateral edge of the humerus brought up, and it is clearly marked by the alignment of external tuberosity, deltoid ridge, and external condyle for the radius (fig. 2).

The other modifications, the extreme shortening and the anterior displacement, may be correlated with the necessity of bringing the pectoral limb alongside a very narrow part of the body. To allow progression in a confined space the limb must not project very far out,

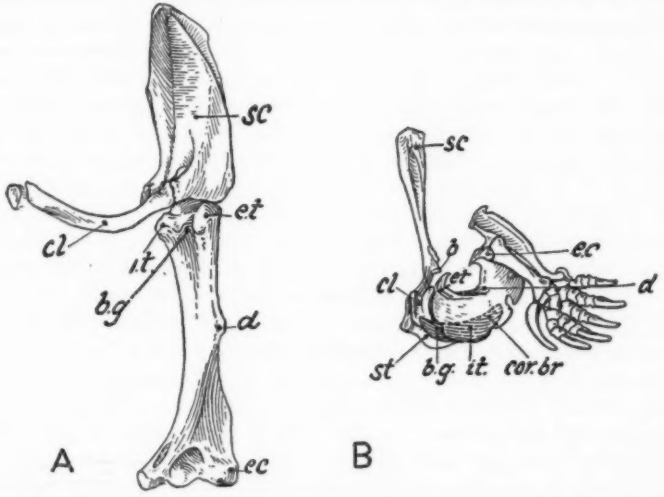

FIG. 2. COMPARISON OF (A) A NORMAL GIRDLE (PHALANGISTA) WITH THAT OF (B) A MOLE (SCALOPUS SP.)

b, origin of the biceps; *b.g.*, bicipital groove; *c.*, clavicle; *cor. br.*, hypothetical extent of coraco-brachialis to posterior side of humerus if the clavicle were the coracoid; *d*, deltoid ridge; *e.c.*, external condyle for radius; *e.t.*, external tuberosity of humerus; *i.t.*, internal tuberosity; *sc*, scapula; *st*, sternum.

and still the normal length of the limb must be maintained for its advantageous leverage for the muscles. The elongated manubrium sterni carrying with it the clavicles brings them alongside the very narrow neck region, and the shortening of the clavicles allows the limbs to articulate very far in toward the mid-line (fig. 5).

Vialleton denies that these very plausible modifications have taken place. Instead, he maintains that the element called clavicle is in reality a coracoid. He accounts for the appearance of a coracoid as a

response to the need for a joint to take up the stresses of digging. This response comes not as a modified clavicle as has been supposed, but as the reassertion of a primitive plan with the coracoid articulating with the humerus. Vialleton presents three arguments to support his view. First, he argues, the clavicle and the humerus do not articulate with each other in any other mammal form. On the other hand, this bone, in its articulation with and in its relation to scapula, sternum, and humerus is in the position of a true coracoid. His second line of evidence is embryological. The element in question appears first as a single cartilage. The first ossification of this cartilage is in the dorsal part, and it forms a dorsal bone. The rest of the cartilage then ossifies and fuses with this dorsal bone. The only remnant of the clavicle, Vialleton maintains, is this dorsal element which takes no part in articulating with the humerus. The rest of the bone which articulates with the humerus is the true coracoid. Lastly, Vialleton draws an analogy with the condition in the monotremes. In this group, when the humerus is protracted and retracted in digging, there is a tendency to expand the glenoid cavity in an antero-posterior direction. It is, therefore, necessary to have a solid, buttressed base in the antero-posterior direction, which is provided by the presence of the coracoid. In somewhat the same way, Vialleton supposes, a coracoid appears in the moles.

In general, Vialleton's view is a much too hypothetical and an unnecessarily difficult attempt to explain the facts. It can not be said that he presents any real evidence; and his whole theory rests on one false assumption and one poor analogy. Thus, his first point bears no weight since it depends entirely on the assumption of the improbability of the humero-clavicular joint. Since this joint is improbable, Vialleton argues, the element's articulation with the humerus is diagnostic of its being coracoid. Only the coracoid originally articulates with the humerus as well as with the sternum and scapula. Vialleton does not present any evidence, however, to show that a humero-clavicular articulation could not have formed in the mole. On the other hand, it has already been shown here that all the structural and adaptive considerations make such a joint very likely. There is even more striking evidence for the actuality of this joint in the case of *Galemys*, an aquatic member of the Talpidae, where a perfectly normal clavicle articulates with the humerus (fig. 5). This will be discussed more fully below. Vialleton's assumption is wholly unwarranted.

As for Vialleton's embryological evidence, it is inconclusive, because it deals with centers of ossification rather than with distinct elements.

Many instances of secondary ossification have been described which had little to do with original morphological elements. There is no reason to believe that the ossifications in this very much modified bone are any different. Two different centers of ossification do not warrant being called clavicle and coracoid simply because one is dorsal and one is ventral when there is nothing to indicate that these ossifications represent distinct elements in the first place.

The analogy with the condition in the monotremes, Vialleton's final argument, breaks down because it is between two groups that are so far

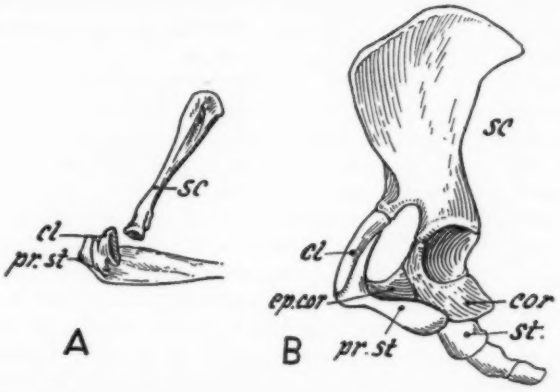

FIG. 3. CONTRAST BETWEEN THE PECTORAL GIRDLES OF (A) A MOLE (TALPA EUROPAEA) AND (B) THE MONOTREME (ECHIDNA SP.) (PARTLY AFTER VIALLETON)

cl, clavicle; *cor*, coracoid; *ep. cor.*, epicoracoid; *pr. st.*, presternum; *sc*, scapula; *st*, sternum.

apart. Each group adapts itself to a given function in its own way. It is wrong to suppose that because both groups dig there will be a similar set of conditions in each. The contrary is the fact; adaptations to what seems to be even an identical function are of the utmost diversity in different groups. The adaptation in the monotremes in no way indicates what the adaptation in the moles will be. A comparison of the two pectoral girdles shows that the conditions in the two forms are indeed radically different (fig. 3). Whereas the monotreme humerus articulates with an extensive and complete set of elements, the mole humerus is propped up against a distinctly anterior element. The glenoid fossa in the mole is not surrounded on all sides as it is in the

monotremes. The fossa itself is different, for in the monotremes the coracoid simply helps form a single fossa for the head of the humerus. In the moles, on the contrary, the humerus has two distinct articular heads, one of which fits into the fossa on the clavicle while the other, the original head of the humerus, fits into the fossa on the scapula. It can not be said that clavicle and scapula form a single fossa. Then, if the mole humerus articulates with a coracoid, why should not this coracoid have a wide posterior extent like that of the monotreme? The only answer is that the two conditions are not to be compared.

Turning now to the more positive evidence that the bone is a clavicle, the musculature is very significant. The musculature, according to Dobson's monograph, shows that the normal coracoid muscles do not come from the bone in question, while the normal clavicular muscles are all present in their typical arrangement. The two muscles which normally originate from the coracoid are the coraco-brachialis and the biceps. The former is entirely missing in the mole, and the latter originates from its usual place on the scapula and not from Vialleton's "coracoid" (fig. 2, b). The absence of the coraco-brachialis can hardly be correlated with as large a coracoid as would be that of the mole, according to Vialleton. Nor can this absence be accounted for on the basis of loss of function, because the coraco-brachialis would be a good digging muscle. Its normal insertion is on the side of the humerus opposite the ridge of the deltoideus, and if we indicate approximately where this muscle would be (fig. 2, cor. br.) if this bone were a coracoid, it is evident that it would pull the humerus backward, a very valuable digging function. As for the biceps, the mole scapula is very specialized, and the coracoid process can hardly be made out, but the biceps comes from the upper margin of the glenoid cavity where the coracoid should normally be (fig. 2). Its tendon then passes normally through the bicipital groove and inserts on the ulnar side of the radius. To still hold that the clavicle is a coracoid, Vialleton would have to assume that the coracoid had shifted, leaving the biceps in place, a very unlikely occurrence.

Of the muscles that do normally originate or insert on the clavicle there are three which may be called distinctly clavicular. That is, they are not slips of other larger muscles to the clavicle. They originate or insert wholly on the clavicle. These are the cleido-mastoideus, the cleido-occipital, and the subclavius, and in the mole all three are present (fig. 4). When the clavicular musculature in the mole is now compared with that of a normal form like *Echinosorex* (fig. 4), it is evident that the

relations of these three muscles to one another are identical in both cases. In both forms the origin of the cleido-occipitalis is right near that of the cleido-mastoideus and on the same side of it, and the subclavius inserts on the posterior edge of the clavicle. Other muscles normally send slips to the clavicle, and thus the *Echinosorex* clavicle receives two slips from the pectoralis major. The clavicle of the mole receives one, and it is in exactly the same position as one of the slips in *Echinosorex*, external and next to the cleido-occipitalis. The deltoideus muscle in the mole also originates from the clavicle while it does not in *Echinosorex*, but this spreading of the deltoideus over the clavicle is perfectly normal and is to be found in many other forms. One other muscle is figured by

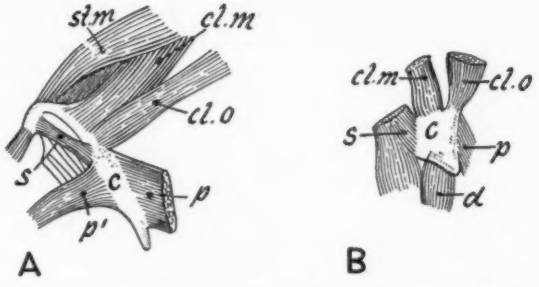

FIG. 4. CLAVICULAR MUSCULATURE OF (A) A NORMAL FORM (ECHINOSOREX) COMPARED WITH THAT OF (B) A MOLE (CONDYLURA CRISTATA). VENTRAL VIEW OF LEFT SIDE. (AFTER DOBSON)

c, clavicle; *cl. m*, cleido-mastoideus; *cl. o*, cleido-occipital; *d*, deltoideus; *p*, pectoralis major; *s*, subclavius; *st. m*, sterno-mastoideus.

Dobson as inserting on the clavicle, although Dobson does not describe it. This is the sterno-scapularis, sometimes called the subclavius posticus. It usually originates together with the subclavius and passes over the dorsal side of the clavicle to insert on the metacromion process. In the mole, part of the muscle seems to attach to the dorsal side of the clavicle on its way to the metacromion. In a word, the entire musculature agrees with the homology of the bone as a clavicle.

It might be said, however, that Dobson's naming of the muscles was influenced by the assumption he started out with, that he was dealing with a clavicle, but it is not alone from their arrangement on the clavicle that the muscles derive their names. Their other relations, too, indicate that Dobson homologized these muscles correctly. The origin

of the subclavius and the insertion of the cleido-mastoideus and the cleido-occipitalis correspond very well with the normal condition. In both *Echinosorex* and the mole the subclavius originates from the first rib. The cleido-mastoideus can hardly be mistaken, for in the mole as well as in *Echinosorex* it joins the sterno-mastoideus, and the two form a single insertion on the mastoid. The sterno-mastoideus in the mole is not figured here, but its condition is identical with that in *Echinosorex*. The cleido-occipitalis is described as inserting on the occipital bone in the mole and into the occipital crest in *Echinosorex*. The muscles thus agree thoroughly in both their insertions and origins, and it is only natural to conclude that they attach to a clavicle in the mole as in *Echinosorex*. Since it has no scapular origin and originates wholly from the clavicle, the deltoideus is the only muscle about which any

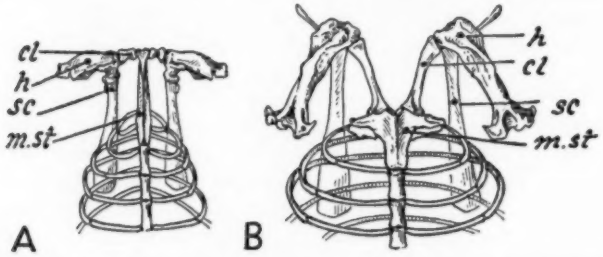

FIG. 5. THE HUMERO-CLAVICULAR ARTICULATION IN (A) A MOLE (SCALOPUS) AND IN (B) GALEMYS, SHOWING THE NORMAL CLAVICLE IN GALEMYS
cl, clavicle; *h*, humerus; *sc*, scapula; *m.st*, manubrium sterni

question might be raised. Extending from clavicle to humerus it might be called the coraco-brachialis, under Vialleton's view. It is clear, however, that the deltoideus inserts on the wrong side of the humerus to be the coraco-brachialis (fig. 2, d, cor. br.). The loss of the scapular origin of the deltoideus may be correlated with the fact that there is very little up-and-down motion of the humerus in the mole. In the same way the teres minor, which has usually a wide scapular origin, is in the mole entirely lost. Dobson's nomenclature seems to be well founded and the conclusion that the musculature is typically clavicular is valid.

The condition in *Galemys* has already been referred to in connection with Vialleton's objection to the humero-clavicular joint. This aquatic member of the mole family throws a good deal of light on the whole

problem of the clavicle. Here the humerus articulates with what looks to be in every way a normal clavicle (fig. 5). The clavicle is not shortened and anteriorly displaced as it is in the true moles. There can be no doubt that what seems to be a clavicle really is one. In its shape as well as in its position it is typical, although in the figure shown here, which was drawn from a dried specimen, the clavicle points more anteriorly than it should. Dobson's figure of a mounted skeleton of *Galemys* from the side shows that the clavicle must point almost directly outward. It may be pointed out that the musculature of the *Galemys* clavicle is also normal.

Galemys seems to be much more primitive than the true moles. In the structure of the skull and dentition, the humerus, the manus, the shape of the manubrium sterni, and the clavicle itself, *Galemys* is much less specialized. Likewise it has a normal teres minor and a scapular origin for the deltoideus which the true moles lack. Since all the Talpidae, from the extremely fossorial *Scalopus* to the shrew-like *Uropsilus* which does not use its limbs for digging, agree in the humero-clavicular joint, it is quite certain that the group has descended from a common ancestor that already had acquired this joint. If *Galemys* is thus considered nearer to the group stem and more generalized than the true moles, it represents something similar to one of the hypothetical stages in the development to the true mole condition. It seems that the humero-clavicular articulation was the first adaptation in this fossorial ancestor of the group. The actuality of this articulation can no longer be doubted when the condition in *Galemys* is known. Then as the animals in the line toward the true moles became more and more fossorial, shortening and anterior displacement of the clavicle took place. In other directions there was the development to forms like *Galemys* and *Uropsilus*.

The evidence presented, together with the weakness of the view that would make of it a coracoid, leads to the conclusion that the mole clavicle is in every way directly homologous to that of other mammals. It must be considered simply as an extremely fossorial modification.

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NOTES ON THE HABITS OF CYCLOPES DORSALIS

By Josselyn Van Tyne

[*Plate 23*]

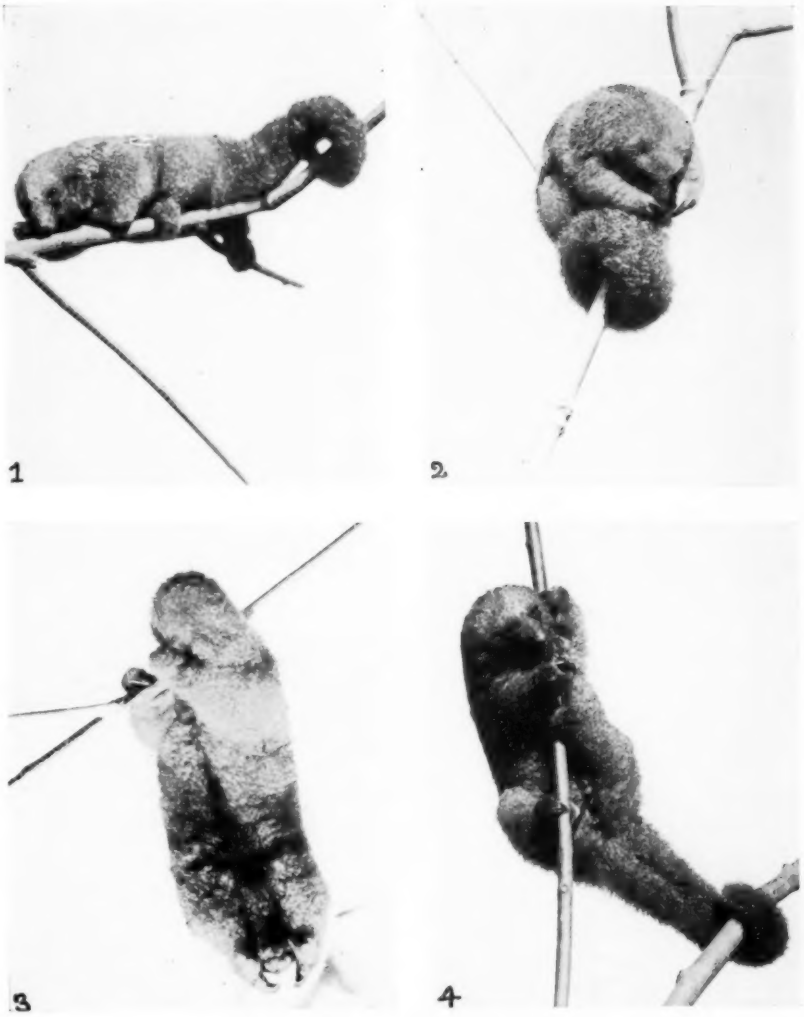
While working recently at the Barro Colorado Biological Station in the Panama Canal Zone, I had the opportunity of observing the habits of the beautiful little two-toed ant-eater (*Cyclopes dorsalis*). On the morning of March 11, 1927, some negroes cutting at the edge of a tiny clearing at the highest point on Barro Colorado Island captured the little ant-eater as it was climbing slowly through the top of a tall bush. They brought it to me and I kept it alive for several days. But it was never very active in the day time. At night it moved about much more, but even then with a slowness very reminiscent of a sloth. When climbing in a tree, it moved very deliberately, grasping the twigs firmly with its strongly prehensile tail as well as with its strangely specialized feet.

Sunlight was very repugnant to it and it usually kept its eyes closed to mere slits in the daytime, even when moving about. If undisturbed it would soon curl up in a crotch and immediately fall asleep.

When startled, it showed a most remarkable reaction. With a peculiar little sneeze it would suddenly let go with its fore feet and straighten out stiffly, clinging to the perch with only its hind feet and prehensile tail. In this "defence position," as well shown in the photograph, the fore feet are held stiffly on each side of the nose and partly covering the eyes. After holding this peculiar position rigidly for a half a minute to a minute, it would, if the danger seemed past, gradually relax and resume its normal activities. Bates (Naturalist on the Amazons, 1883, vol. 1, p. 178) apparently observed the same reaction in the Brazilian form which he says "when irritated * * * reared itself on its hind legs from the back of a chair to which it clung, and clawed out with its fore paws like a cat." But this rather misrepresents the reaction. It is merely the sudden assuming of an attitude in which the fore feet are extended forward. Although handled by all of us, it was very gentle and never made any attempt to claw us.

All of the photographs reproduced here were taken by my companion, Walter E. Hastings.

Museum of Zoology, University of Michigan, Ann Arbor, Michigan.



TWO-TOED ANT-EATER
1. WALKING. 2. ASLEEP. 3. ALARMED. 4. CLIMBING

HABITS OF SYLVILAGUS AQUATICUS LITTORALIS

By Ruth Dowell Svihla

[*Plate 24*]

The rabbit of southern Louisiana, *Sylvilagus aquaticus littoralis*, occurs abundantly in the gulf coastal marshes. During the years 1926 and 1927, while in the marsh region about ten miles south of Morgan City, I made observations upon the habits of this rabbit. Both adult and young rabbits were also kept in captivity and observed.

Nelson[1] calls this animal the coast swamp rabbit, as it is the subspecies of *Sylvilagus aquaticus* that is restricted to the narrow belt of swamps and marshes along the gulf coast. Locally, this rabbit is known as the marsh rabbit, for the term swamp is applied to the extensive cypress swamps which are north of the coastal marsh region and where the swamp rabbit or true *aquaticus* is found.

The marshes consist of vast stretches of semi-aquatic grasses and sedges, chief among which are *Phragmites communis* or giant roseau, *Panicum hemitomum*, *Spartina patens juncea*, *Spartina cynosuroides* or paille fine, *Scirpus robustus* or three-cornered grass, *Typha latifolia*, and *Typha angustifolia* or bulrush. On the slightly higher and drier situations, blackberry bushes are common. Intersecting the marsh prairies, are numerous bayous, the banks of which are somewhat higher than the prairie proper and so are normally above tidal limits. Tree islands of various extents, covered by willows, live oaks, gum trees and cypress, occasionally break the prairie landscape.

It is under the tangled marsh vegetation and brier bushes that afford excellent cover, that the marsh rabbits have their forms and runways. They range over the entire marsh region including the tree islands whenever too much water does not prevent their easy travel. Many old nests made of grasses and rabbit fur have been found on the marsh. These nests are especially noticeable after the marsh has been burned. Only once, April 27, 1927 (pl. 24, figs. 1–3) were young rabbits found in a nest of this sort. It was located near the edge of a wooded area and was made of Spanish moss (*Dendropogon usneoides*) and rabbit fur. Six young were here, all of which had their eyes open and were able to run about. They were still young, however, averaging only seventy-eight grams in weight.

[1] Nelson, E. W. 1909. The Rabbits of North America. North Amer. Fauna no. 29.

Marsh rabbits take easily to the water. I have seen very small ones, scarcely a quarter-grown, swim. The adults swim with no particular speed and a dog can easily overtake them in the water. In eluding dogs, they often lie very still in the water under some bush or floating piece of wood so that only their noses are visible. When caught or hurt, they emit loud terrifying squeals, which is the only sound they have been heard to utter. Kept in captivity (pl. 24, fig. 4), they remain extremely wild and nervous and do not become accustomed to their cages, even after months of confinement. They fight standing on their hind feet and use the claws of their front feet and their teeth to inflict wounds. Often they jump clear off the ground, striking their opponent with the claws of their hind feet. Their claws are so sharp that many times great gashes are torn in the pelt of their adversary. One male killed outright a half-grown male and an adult female, which were introduced into his cage, but did not injure his original female cage-mate.

Young rabbits or embryos have been found during the following months:

	Young	*Females with embryos*
January	3	0
February	4	2
March	1	0
April	8	1
June	1	0
August	6	0
September	2	0

The number of young in a litter ranged from one to six. The number of embryos ranged from three to five, with an average of three and seven-tenths. An interesting case of delayed parturition happened in a female marsh rabbit. The day after the severe hurricane of August 24, 1926, the water was very high, covering most of the vegetation. Six rabbits, which had taken refuge on floating boards and mats of grasses, were captured and placed in cages about two o'clock in the afternoon of August 25. At four o'clock, upon looking into the cage of one of the females, I found a newly born young (pl. 24, fig. 5). The young rabbit was dead, weighed 55.7 grams, and was blind, but covered with hair, contrary to the general assumption that the young are born hairless. The young rabbit was preserved and is now in the United States National Museum. The next day, August 26, this same female gave birth to another young. She had eaten all but the head when it was

discovered. This was also preserved as a specimen. Two days later, August 28, a third young was born. This time the female ate all but the hind legs. The following day the female was found dead. The rabbit had been kept in a small cage, and no doubt the unusual and disturbing conditions had much to do with this long period of parturition. Concerning the hairiness of the young at birth, this can not be necessarily an abnormal case for well developed fetuses have been found that are distinctly covered with hair.

On April 27, 1927, six very young rabbits were located in a nest at the base of an old cypress stump. The nest was on the ground in the crotch between two "knees" and was made of Spanish moss and rabbit fur, with which the young were covered. Their eyes were open, their fur was well developed, and they were able to run about. They were brought home and raised.

TABLE 1

Weights taken at different intervals and showing growth of six rabbits of same litter

DATE	GREATEST WEIGHT	LEAST WEIGHT	AVERAGE WEIGHT
	gms.	*gms.*	*gms.*
April 27	91	64	78.6
May 1	96	73.5	80.6
May 4	100.7	79	90
May 8	108	84	97.3
May 12	129	97	112.6
May 16	150	109	130.1
May 20	159	116	144

For the first two days, they were fed every six hours a warm mixture of two tablespoonfuls of condensed milk, four tablespoonfuls of water, one-half tablespoonful of lime water and a quarter of a teaspoonful of sugar. This was given by means of an ordinary medicine dropper, and each rabbit drank three dropperfuls at a meal. After the first two days, they were fed three times a day and their portion gradually increased, until by the seventh day they were drinking six dropperfuls apiece twice a day. By the fourth day they were nibbling at apple and in ten days time they could help themselves to apple, graham cracker, grass and sprouted oats. By this time, they were very lively and playful, running about surprisingly fast and trying to kick awkwardly with their hind legs. When caught suddenly by the hind legs, they uttered a scream like that of an adult rabbit. Their growth is shown in table 1.

The fact that they weighed on an average of 78.6 grams when first caught and that a young rabbit newly born in captivity weighed 55.7 grams, seems to show that these rabbits could not have been more than a few days old at most when first captured.

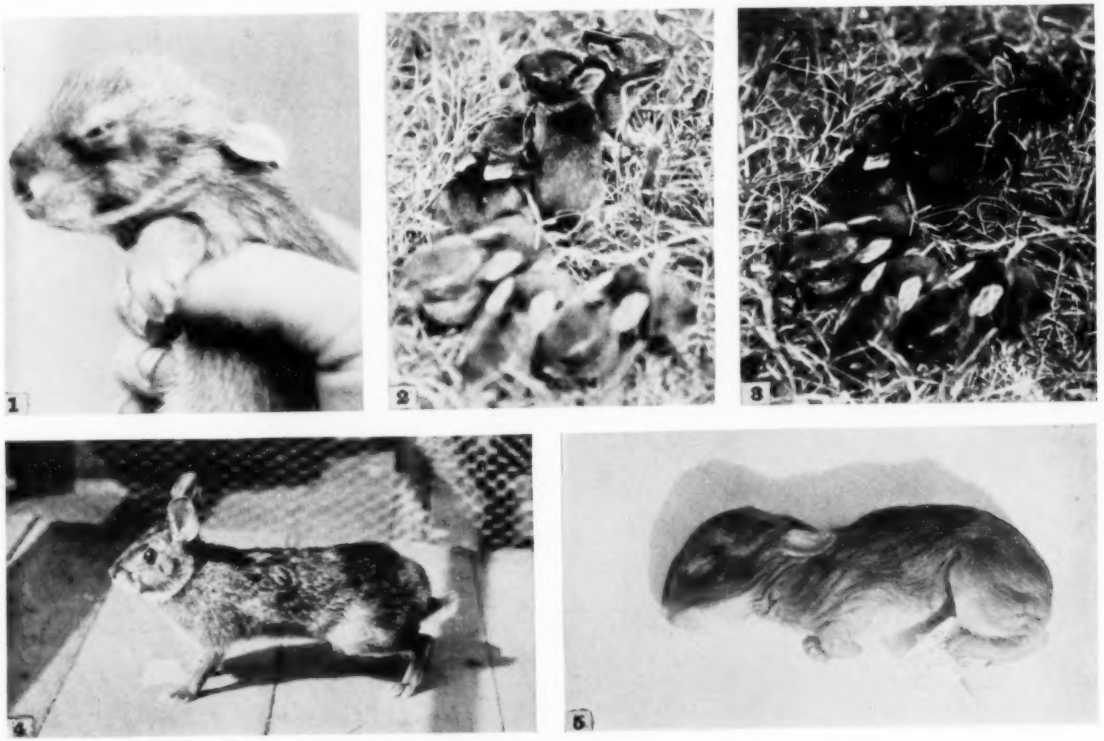
In nature, the various marsh grasses and sedges provide excellent food for these rabbits throughout the year. In captivity, they have eaten fresh and dry corn, rolled oats, oat seedlings, grass, weeds, clover, apples, celery, carrots, muskmelon, and watermelon. For two weeks, the amount of grass and weeds fed to a pair of rabbits was weighed, and the amount that they consumed, computed. The food was weighed when given in the evening, and what was left was weighed again the next morning so that as little as possible was lost through evaporation. The grasses included such species as *Spartina patens juncea* and *Panicum hemitomum*, while among the weeds were thistles, burdocks, and plantains. The weight of the food consumed by the rabbits follows:

Total weight consumed in 2 weeks	39 pounds 11 ounces
Average weight consumed each day	2 pounds 13.3 ounces
Average weight consumed each day by each rabbit	1 pound 6.6 ounces
Average weight of 1 rabbit	3 pounds 5.5 ounces
Per cent of weight consumed	42.2

Thus each rabbit ate on an average of almost half its weight every day.

These rabbits were infested with fleas and ticks practically throughout the year, while warbles were found on them during the spring and early summer. I have also found intestinal tapeworms in many rabbits. Analyses of alligator stomachs (*Alligator mississippiensis*) show that this is another enemy of the marsh rabbit.

Except for extensive hunting by man, perhaps the most important factor in reducing the number of rabbits is high water remaining over the marsh for any length of time. This not only floods their forms and runways, but also rots the vegetation, so that both food and cover are destroyed. After the tropical hurricane of August 24, 1926, Avoca Island, which is drained artificially, was flooded for three weeks. During this time, the rabbits sought refuge on floating boards and clumps of roseaux (*Phragmites communis*). Over a dozen rabbits were caught during one day, and all were in a more or less emaciated condition. After the water had receded, rabbit carcasses and skeletons were common everywhere. During a walk of about a quarter of a mile on Avoca Island, over twenty carcasses were counted.



SYLVILAGUS AQUATICUS LITTORALIS

FIG. 1. YOUNG RABBIT WHEN CAPTURED APRIL 27, 1927. FIG. 2. YOUNG RABBITS MAY 8, 1927. FIG. 3. YOUNG RABBITS MAY 12, 1927. FIG. 4. ADULT RABBIT KEPT IN CAPTIVITY. FIG. 5. NEWLY BORN YOUNG AUGUST 25, 1926

Although the pelt of the marsh rabbit is of no commercial value, the flesh is utilized for food. During a favorable season when rabbits are abundant, they provide great sport for hunters, who use dogs and fire to drive them from the extremely thick vegetation. When they are numerous, a bag of fifty to even a hundred rabbits a day is not uncommon for a hunter. However, after floods or fires have destroyed the vegetation so that food and cover are scarce, the rabbits are by no means so abundant.

University Museums, University of Michigan, Ann Arbor, Michigan.

SUMMER OUTINGS OF BATS DURING FOURTEEN SEASONS

By Althea R. Sherman

As many a mammalogist will bear witness, bats are difficult animals to study. If this article achieves no other result, it may serve to confirm this statement by showing the meagerness of facts gleaned in fourteen summers of unremitting study. These years were those of 1915 to 1928 inclusive, during which daily notes were kept and effort made to see as much as possible of bat activity at my home at National, Iowa. There are a few written notes taken in 1908 and earlier, besides some memory fragments for a portion of the sixty-odd years that bats have been window tenants of the family residence.

Acknowledgments for help received are due to Vernon Bailey for identification of bats and his report thereon; to my sister, Dr. E. Amelia Sherman, for numerous observations that would have escaped my notice; and to James L. Woods, Jr., of whose assistance I shall speak farther on.

For the most part, this study of bats has been limited to observations of them in the air and to their behavior as they hung in the windows behind outside blinds. For convenience in note keeping the windows were numbered, beginning at the southwest corner of the house. Because the house stands parallel with the highway which runs northwest to southeast at an angle from meridian lines approximating twenty or more degrees, the so-called north side of the house receives several hours of afternoon sunshine in midsummer. Windows nos. 1 to 5 are west ones, nos. 6,7, and 8 are north ones. The upper windows on the east side of the house do not enter into this history, since no bat is remem-

bered to have been seen in any of them during the sixty-two years of house occupancy. Before the fourteen years of intensive study of bats began they easily might have escaped observation, but in housecleaning their excrements would have been found. For several years after note keeping was undertaken all east windows with closed blinds were examined daily.

The window part of this study is concerned mainly with the upper ones, numbered from 1 to 8 inclusive. The blinds of no. 1 have been open except in the summer of 1915. Those of no. 2 are sometimes open, yet often shut. Those of nos. 3 to 7 are generally shut, while those of no. 8 are usually open. Window no. 7 has not been accessible for investigation. The blinds of the two windows on the south end of the house are always open. When the sun becomes very hot the bats desert the west windows. At such times not infrequently a bat has been found back of the open half of a blind of a lower east window which is sheltered by a porch. On August 26, 1925, a pair in copulation was found behind the closed blinds of one of these east windows. Of the other downstairs windows the one below no. 2 is shut only during the hottest days. It occasionally has been occupied, although this thing has never been known to occur behind the constantly closed blinds of the window below no. 5 which of all the upper windows is chosen most frequently.

Of these window lodgers there have been two species: the large brown bat (*Eptesicus fuscus*) and the little brown bat (*Myotis lucifugus*). Specimens of the latter bat, sent to Vernon Bailey, were pronounced by him as belonging to this species. Although the large brown bat has not had authoritative identification, yet comparisons of it with the little brown bat, hanging in the same window, sometimes hugged closely against each other, lend confidence to the belief that this is the correct identification. Of these two species the little bat is much more numerous. When in daytime both species have been found present, I have felt certain of the distinguishing difference in size, when the bats were on the wing. At other times, when I lacked perfect confidence in this sort of identification, the record has gone to the little brown bat, thereby it may have gained a trifle more numbers than belonged to it. An actual count of their records shows the little bat outnumbering sixteen to one the large brown bat.

For the years since 1915, when the more careful observations of bats were begun, the median date for the first bat seen in the spring is May 13; the earliest date has been May 2 (three springs having claimed this

date); and the latest arrival date has been May 30. For this difference of four weeks between earliest and latest arrival dates no acceptable explanation can be found. Based on the Weather Bureau reports of temperature and precipitation, no correlation between arrivals and weather conditions is apparent.

It has been a far greater task to secure the dates for the last appearance of a bat in the fall. At that season the evening flight about the house often is very brief and it requires constant attention to obtain the record. Many a time have I taken my supper out of doors to eat, while the watch was maintained. Later, while making certain that the last bat of the year had been seen, for two or three weeks at the flying hour I have undertaken some outside task. The latest date on which a bat has been seen was October 16; the earliest bat disappearance was on September 19. Seven disappearance dates have been in September and seven in October. The median date for departure has been October 3. The shortest period for bat summer outings was 132 days, the longest was 161 days, and the average period for fourteen seasons was 143 days. These periods make a total of 2005 days, which means 2005 days of watching for bats on the wing and of examination of windows to see if any were roosting behind the blinds. Occasionally these tasks were neglected, but on the whole the records are fairly constant.

In summer time a few midnight examinations of windows have been made without finding that the bats had returned to the corners which they occupied the next day. About twenty-five years ago my sister noted that the return hour of a bat to the window of her room was soon after eleven o'clock. Shortly before the bats' autumn departure their evening absences from the windows are brief, frequently an hour or two, and there is one definite record of only forty-five minutes. Some of the most interesting observations on bats have been in connection with their drowsy habits before they leave in October. The lethargic disposition displayed seems to be a precursor of the torpor of hibernation. The beginning of this condition has been noted as early as September 20. For four days, including that date, a bat was found constantly in its window corner. Then it took an outing of three hours, and the next evening it again went out. After that it spent six days in its chosen window without leaving it so far as close watchfulness could determine. On four of the six days it staid tucked closely into its corner, but on the sunshiny afternoon of the fifth day it stretched itself out on the slats of the blinds, where it remained for twenty-four hours. On the evenings of October 1 and 2 it went out. On the latter day it

showed wakefulness, it several times lifted its head as if taking heed of its observer and it scratched its side. Beginning with October 3 there was another period of six days, when the bat did not go out. On the first and second of these days it was stretched out on the slats of the blinds, after which it remained motionless in its corner from which it took permanent leave in the evening of October 8. It seemed well established that on only four evenings of nineteen days did this bat leave its window. It was a large brown bat, but the leave takings of the little brown bat are similar when it stays late, although it has never been watched through so long a sleepy period. In explanation of the term watchfulness used in this connection it may be said that the somnolent bats received numerous daytime visits and that until nine or ten o'clock in the evenings regular half-hour visits were made to them. Without a single exception in every autumn in which a bat has remained until October there have been killing frosts before it left. October 10 has been its median date for the seven October departures, while September 28 was median date for killing frosts. Usually there are warm pleasant days with many insects in the air after the bats have left. But their summer outing is over, their winter sleep has begun.

It would be a matter for great satisfaction to know the place of hibernation of these summer tenants, whether it is with the females of their species, or elsewhere. It is known that many of our window lodgers are males, probably most of them are. The very appreciable increase in bat numbers in late July and August, most likely, is due to the presence of females that have come out seeking mates. The meager data collected on this mating have been for August and the birth of their young about the middle of June. Nine miles by air line from my place of study is a large house in McGregor, Iowa, that is the home of little brown bats all the year round. Bats killed there in summer were females. It has not been learned whether the house is strictly a bat gynecium, or if also it is the hibernation place of the males that in very small numbers are found in summer about most country homes. Eleven years ago James L. Woods, Jr., was a schoolboy living in this McGregor house, infested with bat plagues that wintered about the enormous chimneys and summered in the lofty well-lighted attic. His mother thought there were a thousand of these unwelcomed denizens; on one day 211 of them were killed.

In the hibernating season of 1917–1918 the coöperation of the lad, James Woods, was procured for some bat observations. He was to take daily notes in fall and spring, and in winter once each week he was to

listen about the chimneys for bat noises, if any were to be heard. He saw two bats flying on October 14. These were his last, and the date is of special interest, because I saw a bat on October 16. He heard many bat squeakings in the evenings of October 13 and 14. On December 15 he wrote this note, "I heard a squeak like a bat coming from a chimney that had a fire in it." This was the only sound, real or suppositional, that was reported from October 14 to April 5. After the latter date squeakings were heard daily, but a bat on the wing was not seen until April 16. On the three evenings that followed, bat numbers were estimated at 25, 100, and 150, the estimate increasing to 200 before the end of April, after which the estimated number fell to 50 in May. From May 5 to 11, the weather was unpleasant, it being cool, windy, and rainy. On those evenings he saw no flying bats. About this time the chimneys were no longer reported as resorts of the bats, but they were found clinging to the rafters in the attic.

In connection with this report of the diminution of flying bats in the first week of May, it may be well to recall that my earliest date for seeing bats has been May 2. It was May 22 in 1918, the year under consideration. It seems to be a reasonable conjecture that early May is the time for the dispersal of the males of the little brown bat for their summer outings in all the surrounding country. So far as can be learned from my observations and those of my neighbors the number is few of the bats that are seen about each set of buildings. If seen at all, there are no more than two or three locally in an evening until late July and August, when sometimes four, five, and very rarely six may be counted. Aided by my neighbor's children on August 5, 1927, a count of flying bats was made along the roads, covering more than a quarter of a mile to the north and about the same distance to the west. The number was sixteen, counted at the hour they come from their various roosting places. Lest these figures for abundance in midsummer prove misleading, it should be remembered that there are days in spring and fall when no bats are seen. In 1926 the largest count was made. That season lasted 140 days and 271 bat occurrences were recorded. The daily bat average is one for each of the 2005 days of the entire fourteen seasons.

Several times it has happened that a month or more has passed without a bat's having been found roosting in a window. Seldom have more than two windows had occupants on the same day. Seven times there have been records of bats in three windows to which must be added the two days when there were four bats. There are never seen any signs of

friendly companionship, nor a desire for close proximity, each bat claiming a window for itself. On the few occasions when two bats have occupied the same corner, it usually has marked the arrival of a large brown bat that on the following day held the corner alone. Very seldom has a bat claimed a window for more than seven successive days. An exception to this occurred in 1915. That summer in window no. 1 a large brown bat was missing on only seven days out of sixty-five, and a little brown bat in window no. 5 was equally constant for forty-one days. There seem to be two reasons why 1915 was an exceptional season for bat constancy: The temperature was unusually cool and there was lack of disturbance throughout the house. The preceding summer the house was closed during the absence of its owners, and again in 1915 for nine days of June, after which all blinds were kept closed the rest of the season for study of the bats.

In their selections of windows these lodgers have shown decided preferences for which no explanation can be offered. Window no. 5 is the favorite one, it having been chosen more times than all the other windows combined, and nearly three times as often as the next most popular one, which is window no. 3. This selection is closely followed by that of no. 6 which is on the so-called north side of the house. A greater puzzle than this selection of windows has been their choice of left-hand or right-hand corners for occupancy by day. In 1915 a trifle over one per cent of the time all of the bats chose the right-hand corner. Why on nearly 99 per cent of the occasions the left-hand corner was preferred seemed to call for investigation. Repeated coats of paint have fixed the slats of the blinds rather firmly. They can be moved, but have not been changed during this study. Possibly some slight change in the angles of the slats of the blinds of windows no. 3 and no. 5 might have reversed the figures. As they now stand in no. 3 a choice of the right corner has been made on 96 per cent of the days with a 4 per cent preference for the left corner, while the exact opposite of these figures is maintained in the threefold number of choices made in window no. 5. In window no. 6, a 100 per cent choice of the left corner has been indicated. For four summers a careful record of these selections was kept, then a change in the method of keeping notes was made and the records of corner choices were discontinued, to be resumed in the fourteenth season. In the interim the subject was not forgotten and it was noted that the corners occupied continued to hold about the same percentages of choice.

"The first act of the bat, after emerging in the evening from its

retreat, is to fly to the water." This is a statement made by Harrison Allen and frequently repeated by others. However true this may be of many, perhaps most of them, the two species of this study have given no corroboration of it. They have been seen to leave their windows and begin hunting for food at once. In very dry seasons the nearby brooks are dried up, and the nearest water accessible to bats is distant a quarter of a mile. Their favorite hunting place has been a space about fifty feet square, bounded on the east by a tall spruce tree opposite two apple trees on the west, with house and barn forming north and south boundaries. In recent years growing trees have helped to form a similar space on the north side of the house, which likewise attracts them. From both spaces many excursions are made on all sides with speedy returns to the favorite open spaces. Mention has already been made of the frequent briefness of their flights about the house on some evenings shortly before the final leave-taking of our summer tenants. During the rest of the season the period for skimming the air usually is from fifteen to thirty minutes. Then they disappear for the night, and never on a single occasion have appeared that night, though often sought on bright moonlight evenings, when they easily could be seen, if present. Not infrequently they swoop close to the ground, but the average height of flight would be found to lie between fourteen and twenty feet above the ground. Sometimes from the customary height they gradually move upward in a spiral course until they fly above the tallest trees, probably seventy or eighty feet above the ground.

The daytime activities of the bats are rather limited. Usually during the forenoon they remain hanging snugly, head downward, in their favorite corners. This position may not be changed until nightfall, but if the sun's rays heat the blinds sufficiently a bat may leave its corner and coming out on the slats thrust its head and shoulders into one of the openings between the slats, as if seeking a breath of outside air. When the woodwork becomes very hot, frequently the bat changes to the sash of the window and hangs with its underparts against the glass. On such hot days the large brown bat can assume a position of relief not attainable by its smaller relative; with one foot grasping the top of the window and the other the top of the blind without other support it hangs in midair. Whether it faces north or south appears immaterial. Another favorite position is a horizontal one on the slats. This is to be seen more often in autumn days, when the sunshine affords grateful warmth. The large brown bat that spent the summer days of 1915 in window no. 1 furnished daily a very pretty illustration of one of

these habits. The upper slats of the blinds were closed down tightly, but open spaces in the lower-half provided entrance and exit opportunities, as well as breathing places for the bat. To gain them it was obliged to walk down the shutters, and as it moved downward its wings suggested very forcibly the trailing silken garments of a woman in former days, as she walked down a flight of stairs. For many days the bat made this journey very punctually at about half-past eleven in the morning.

Bats, just as human beings do when awakened from sleep and preparing to go abroad, spend considerable time on their toilets. With the bats this time frequently amounts to a half-hour. The little bat is more attentive to toilet making than is his larger relative. One may often come upon a bat cleaning itself in the middle of the day. This activity is a most interesting sight. Not infrequently the bat yawns, showing its white needle-like teeth and its bright-pink tongue. It licks with its tongue the parts readily accessible, such as its sides and belly, but to reach portions of its breast it is necessary to lift the skin with a thumb claw. Once a claw was seen fastened so firmly into the skin that much shaking was used in its release. When an ear is to be cleaned the bat licks a thumb, and, inserting it into the ear, shakes it about very much as a person would his finger. A wing, when its underside is licked, falls over the bat's head like a mantle. For the top of the head, its back and portions of body that can not be reached by the tongue, the bat licks thoroughly a foot and combs its fur with its claws using lightning-like strokes, that move as rapidly as do a hummingbird's wings. To have watched a mother bat caring for her young would have been a highly prized privilege, but it has not been vouchsafed to me. If one has ever come to our place, bearing her young with her, she must have roosted in some other building. To devise arrangements for conducting such observations in the attics, where the female bats spend the summer months, is not suggestive of a difficult undertaking.

National, via McGregor, Iowa.

THE BREEDING SEASON OF THE POCKET GOPHER IN CALIFORNIA

By Joseph Dixon

[*Plate 25*]

Owing to the request of men who are working on problems of rodent control in the west, it seems desirable to put on record at this time certain facts, as yet unpublished, that the writer has ascertained during the past twenty years in California.

The first point of interest is that in this section of the Pacific coast, more particularly in southern and central California, there is a very definite breeding season for the pocket gopher which coincides closely with the beginning of the rainy season. Extensive collecting has shown that the normal breeding season of the gopher in southern California begins about the first week in November. Thus, of eighteen female gophers, taken at that time, at San Bernardino, four were found to contain small embryos, and all but two of the remainder had bred or were ready to breed. In the valleys and along the foothills of California, green vegetation, particularly the alfilaria and malva, which are two of the most important food plants of the gopher, begin to grow at once upon the arrival of the earliest fall rains. The abundance of nutritious green food starts the gophers breeding. The breeding season in the central portion of the state appears to be from ten days to two weeks later than in southern California. Under normal conditions, the mating season extends up until about Christmas.

I have never been able to get gophers to breed in captivity and, therefore, have been unable to determine, by laboratory methods, the period of gestation. At Escondido, San Diego County, on February 7, 1917, my brother, James B. Dixon, secured a nest of young gophers which he sent to me in the flesh. Their measurements and weights were as given in table 1. These young gophers were examined carefully in the flesh and it was found that their eyes were not yet opened. In spite of this fact, freshly chewed green grass was found in their stomachs. Judging from the immature condition of these young gophers, it seems probable that the parent gopher had gathered the green food on the surface of the ground and carried it to the young ones in the nest, where they had eaten the material at their leisure. The incisor teeth of the young female gopher, J. D. no. 5571, were well developed and showed some wear. The pelage of this individual was only slightly developed,

being less than five millimeters in length. The locations of the mammae, two pair inguinal and two pair pectoral, are well shown in the accompanying photograph (see fig. 1).

The evidence indicates that young gophers remain in the nest for several weeks before they venture out and appear on the surface of the ground. On April 27, 1918, on San Emigdio Ranch, Kern County, California, a young gopher (see fig. 2) was found wandering aimlessly about on top of the ground, having come to the surface and then evidently lost his way home. Under normal conditions, the breeding cycle of the gophers in California is closely linked up with the wet winter season. However, it has been found that in alfalfa fields near Turlock, in the central portion of the San Joaquin Valley, where green forage is

TABLE 1

Young Thomomys bottae bottae from Escondido, California

NUMBER	SEX	WEIGHT	MEASUREMENTS
		grams	mm.
J. D. 5569	♂ juv.	42.8	135–34–23–3
J. D. 5570	♂ juv.	41.0	131–30–22–3
J. D. 5571	♀ juv.	36.0	130–30–22–3

abundant throughout the summer, the breeding season of the gopher is correspondingly extended. In the above locality, certain female gophers have been known by the writer each to have lived for a whole year on less than one acre of ground in an alfalfa field. While it was not possible to band, or otherwise to mark the individual gopher, I am reasonably certain that in each case the same individual female was under observation during the entire period. Close observation indicated that where food in the form of green alfalfa was abundant, where temperature was high, as it is in the San Joaquin in summer, and where safe breeding locations were at hand, the gophers reared two, and in some instances three, broods of young in a year. This is one outstanding reason why gophers are so difficult to eradicate in alfalfa fields.

Museum of Vertebrate Zoology, Berkeley, California.

FIG. 1. JUVENILE POCKET GOPHER FOUND IN AN UNDERGROUND NEST AT ESCONDIDO, SAN DIEGO COMPANY, CALIFORNIA, FEBRUARY 12, 1917. ILLUSTRATION $\frac{3}{5}$ NATURAL SIZE

FIG. 2. THIS YOUNG GOPHER CAME OUT OF HIS BURROW AND THEN LOST HIS WAY HOME. SAN EMIGDIO CREEK, KERN COMPANY, CALIFORNIA, APRIL 27, 1918. ILLUSTRATION $\frac{3}{4}$ NATURAL SIZE

THE CRANIAL CHARACTERS OF THE PAPUAN DOG

By Frederic Wood-Jones

As a study subsidiary to that of human racial characters, the writer has embarked upon an examination of the morphological characters of certain domesticated animals. As a general factor in solving the problems of racial movements and racial origins the characteristics of domestic animals can play but little part, since the purity of breed of such domestic animals as dogs is likely to suffer in any racial contact far more than the purity of breed of their owners. But there are conditions under which it is quite conceivable that the characters of even the dog domesticated by a race might provide some clue as to the origin of the race. If this is true anywhere it is likely to be true in the case of the islands of the Pacific. We know quite definitely that the peoples of the Pacific islands were possessed of domestic dogs, pigs and chickens, at their first historic contact with the white man. We know also some very definite facts concerning the race movements of peoples among the Pacific islands; but concerning the origin of these peoples, their continental source, and their actual migrations there are several important phases that stand in need of any extraneous aid that may be called in for their solution. It is possible then that some light may be shed on racial origins and racial movements of the people of the Pacific islands by a comparative study of their domestic animals. Such a study naturally presupposes the possibility of obtaining material representative of the domesticated races in their pure state, as that existed before the possibility of race contamination by the domesticated animals brought in by the white man. In some cases these conditions can not be fulfilled; we can not be assured of the impossibility of race admixture from the white man's importations; but even in these cases there may be sources of evidence which can guarantee some confidence in the racial purity of the specimens examined. In other cases the racial purity can be assured, as far as the influence of the white man's dog is concerned; and it is fortunate that, in the case of certain of the Pacific races, the ancient custom was to incorporate dogs along with human burials in the burial caves of pre-European date. It is, therefore, the writer's intention to review the remains of such dogs as can be obtained from various areas in the Pacific, to describe and illustrate these remains on a uniform plan, and so make available for study scattered material that is not readily accessible either to students of mammalogy or of anthropology.

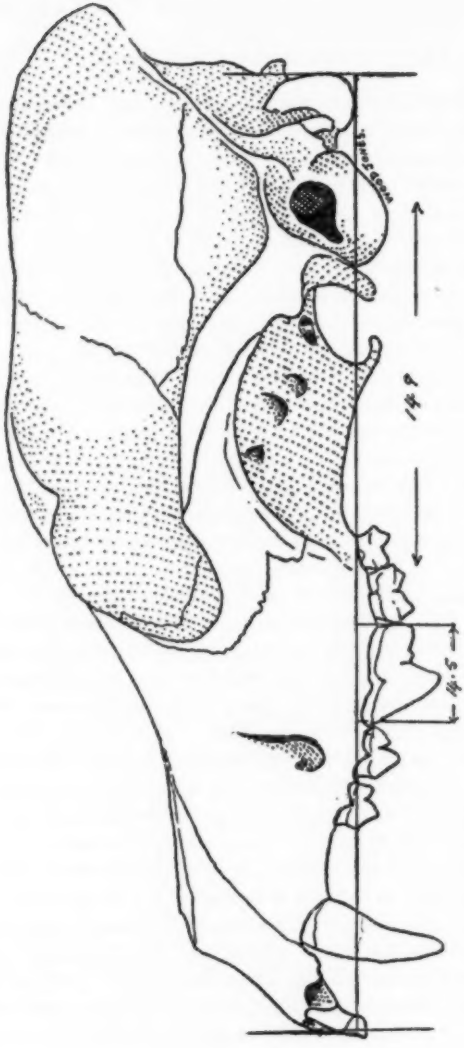


FIG. 1. SKULL OF PAPUAN DOG (QUEENSLAND MUSEUM SPECIMEN 4033). LATERAL VIEW. NATURAL SIZE

In a recent paper (Memoirs of the Queensland Museum, vol. 9, pt. 2, p. 151, June, 1928) Heber Longman, director of the Queensland Museum, made reference to two skulls of Papuan dogs in the collections of the museum. In response to my request, the authorities of the Queensland Museum very kindly permitted me to borrow the two skulls for the purpose of examination and description. As to the provenience of these skulls, Mr. Longmann says that both of them (Q.M.: No. 3751 and Q.M.: No. 4083) were received from his Excellency Sir Hubert Murray. They "came from the Mount Scratchley district in the northern division of Papua, or British New Guinea. As they were originally obtained from the natives, some doubt was expressed by Papuan officials as to whether they were really feral." The actual date of their collection by the natives is not stated.

As to the doubts concerning their feral nature no opinion can be expressed from an examination of the skulls; but it is abundantly evident that both skulls are of dogs of precisely the same type. The two skulls are practically identical, and any suspicion of their being of impure breed is negatived by this remarkable identity. It is certain that these two skulls are of representatives of the same race and that this race is a primitive one. The skulls are those of small dogs of the terrier type, with fairly elongated sharp noses and well developed muscular crests and ridges. Their most outstanding characters are: (a) The form of the supraorbital processes, which are pointed, flat to concave on the upper surface, and singularly vulpine in character (see figure 1). (b) The sagittal crest, which is formed by a coalescence of the temporal ridges in the region of the coronary suture in both specimens, and which is extremely prominent in its caudal extremity where it joins the well marked nuchal crest. (c) The relatively large size of the upper carnassial tooth, the maximum length of which is nearly ten per cent of the condylobasal length. (d) The backward prolongation of the palate behind the last molar tooth, a very well marked distinction of both skulls. (See figure 2.) The measurements of the two skulls are given in table 1.

The coat colour of the Papuan dog skin in the Queensland Museum is "black and white, the black dominant; the white portions are a long irregular patch on the nape, another covering the chin, throat, and breast and contracting to a point on the abdomen, the paws, left tarsus and tip of the tail are white also; the inguinal region tawny white." The second skin is described as being, in general colour, "Ridgway's russet, interspersed with darker hairs, especially on the tail, the limbs being lighter."

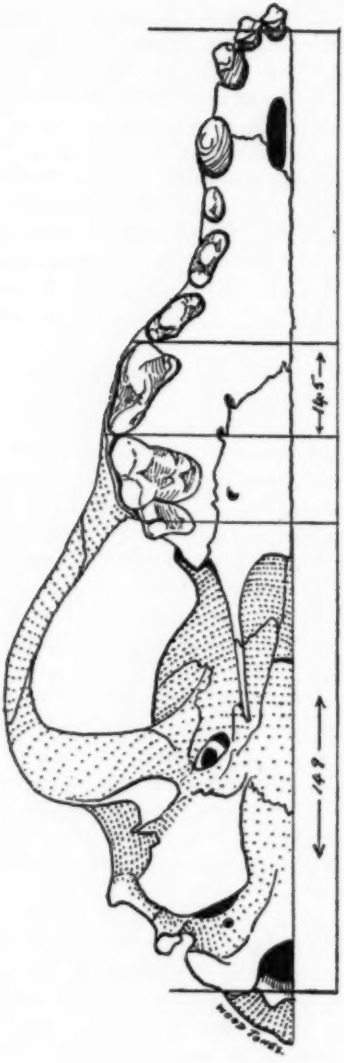


FIG. 2. SKULL OF PAPUAN DOG (QUEENSLAND MUSEUM SPECIMEN 4083). BASAL VIEW. NATURAL SIZE

Although these two skulls constitute the only material available for the study of this dog, they probably afford definite evidence that the Papuan feral dog is a very definite race, possessing a relatively large upper carnassial tooth typical of primitive canine breeds, and differing

TABLE 1

Measurements of two skulls of Papuan dogs

MEASUREMENT	SKULL 4083	SKULL 3751
	mm.	mm.
Condylobasal length	149	147
Maximum length	162	158
Interorbital constriction anterior to process	29	28
Interorbital constriction posterior to process	28	30
Breadth across supraorbital process	42	42
Bi-zygomatic, maximum	90	88
Breadth of brain case at temporal suture	50	50
Length of palate	81	80
Breadth of palate outside canines	30	29
Maximum breadth of palate	54	52
Nasals, lateral length	63	56
Nasals, medial length	55	50
Nasals, maximum breadth	17	12
Upper carnassial, maximum length	15.5	16
Post-canine dental length	54	55

widely in its characters from the dogs of certain other Pacific islands. It is much to be desired that more material should be secured before the crossing by the white man's dogs has rendered the breed too hybridized for the purposes of study.

University of Melbourne, Melbourne, Australia.

INTRODUCED EUROPEAN RABBITS IN THE SAN JUAN ISLANDS, WASHINGTON

By Leo King Couch

[*Plate 26*]

Domestic varieties of the European rabbit have been introduced on several islands of the San Juan Group in the state of Washington, among them being San Juan proper, Smith Island, and Long Island, near Lopez Island. Smith Island was made the object of two visits by the writer, the first being in company with Theo. H. Scheffer, of the U. S. Biological Survey. This island lies nine miles north of Port Townsend, at the entrance to Puget Sound. It is owned by the federal government. The Department of Commerce uses it as a lighthouse station, and the Navy Department as a radio compass station; while the Department of Agriculture administers it as a national bird reservation. The island is nearly round, with a gravel spit on the east leading to Minor Island, an enlarged end of the spit. The elevation varies from a few feet on the spit side to about sixty feet on the west end. The lighthouse, radio station, rain sheds, storage tanks and other buildings are grouped on this higher elevation. The area above high tide mark is about fifty-six acres, four acres of this being wooded.

The commandant of the Bremerton Navy Yard provided us transportation to the island on a mine sweeper *U. S. S. Swallow.* Upon landing, we saw evidence of rabbit depredations everywhere, and animals of various colors—tan, black, white, reddish brown, some spotted, but the majority straight colors—running in all directions. The lighthouse skipper told an interesting story of how the rabbits were brought to the island. About the year 1900, a lighthouse keeper bought a few so-called Belgian hares, with the idea of supplementing his meager income through meat sales to the Seattle markets. Subsequently, at four-year intervals, Black Flemish and New Zealand breeds were introduced to prevent inbreeding. No one on the island knew just how lucrative this venture proved; but a later keeper, not being interested in commercial pursuits, left the rabbits to shift for themselves. The food supply kept up with the pyramidal increase until the spring of 1924, when the Navy Department requested assistance from the U. S. Biological Survey in meeting the problem. At that time the rabbits were undermining the buildings.

At the first visit in May, 1924, practically all the succulent forage was

UPPER FIG. RESULTS OF RABBIT BURROWINGS ON SMITH ISLAND, WASHINGTON
LOWER FIG. SMALL TIMBERED AREA "BARKED" BY RABBITS

eaten close to the ground. Three types of vegetation were plentiful, namely, bracken (*Pteridium aquilium pubescens*), tarweed (*Media exigna*), and cheat (*Bromus* sp.); but the rabbits refused them as food. Douglas firs, dwarfed by the continued winds, were barked where the branches hung low. Industrious burrowing had wreaked vengeance on the island. The ground was upheaved, with openings every few feet. Erosion occurred more rapidly, causing the bluffs to cave into the sea and gradually decreasing the size of the island each year. The destruction of forage and shrubbery no doubt accounted for the lack of nesting birds. Two robins' nests were found; tufted puffins (*Lunda cirrhata*) were in considerable numbers along the bluffs, but not nesting. On our second trip, a lone emaciated California murre (*Uria troile californica*) was observed wandering around through the ferns. On the second day it was caught and posed for a photograph, and then was returned to salt water. Oil on the wings told the story. Shoals around the island were frequented by thousands of these birds. It must be borne in mind that Smith Island is a national bird reservation, where birds formerly rested and congregated in great numbers.

Utilizing the rabbits for food was out of the question, as many of those examined were found to be diseased. Their excessive abundance and malnutrition had left the majority in poor condition. However, only a very few rabbits were noted that had died from natural causes.

Preliminary investigations having been completed, plans were made to reduce the pest. The month of August was selected for the work, since it was the driest season of the year, and a crew was organized to carry out control measures. Sliced apples dusted with strychnine alkaloid were exposed in late afternoon, scattered along the rabbit trails, and the next morning the dead animals were gathered. Rabbit warrens were fumigated during the remainder of the day with calcium cyanide, dusters being employed to force the material into the burrows, where its reaction with moisture liberated cyanogen, a suffocating gas. As a result of the poisoning operations, 621 rabbits were picked up, and it was estimated that twice that number were killed with cyanide in the burrows. After eight days there were few rabbits left, and these appeared extremely wild.

The next year (1925) a short visit was made to the island. Very few rabbits were seen and there was little activity noted. The numerous warrens, ground-cover, and the driftwood piled along the beach makes extermination a problem for the future.

Long Island was stocked with rabbits from Smith Island, according

to residents of Richardson, on Lopez Island. Other islands in the near vicinity, namely, Colville Island and parts of Whidby Island, can no doubt trace their original stock to Smith Island. Islands north and west of Friday Harbor, however, may have been infested from another source. According to Capt. John Pierce, of Olympia, J. A. McCormick and J. M. Edson, of Bellingham, the San Juan, Wasp, Jones, Spieden, Flattop, Johns, Skipjack and Mateo islands are at present the home of imported rabbits. Quoting Mr. Edson: "It is my impression that rabbits have been common on the islands since I came to this region. I visited Skipjack Island as early as June, 1895, and while I have no written record as to the rabbits, it is my recollection that a number of them of different colors were seen on that trip. I suspect that if their history can be traced it will run back to the days when the Hudson's Bay Company occupied this region."

U. S. Biological Survey, Olympia, Washington.

ACTIONS OF THE POCKET GOPHER (GEOMYS BURSARIUS)

By W. J. Breckenridge

I recently undertook to construct a small group for our traveling school-series displaying the mounds of the pocket gopher (*Geomys bursarius*) in vertical section and showing one of the animals at work. While a young boy in eastern Iowa, I had trapped hundreds of these animals, but had never observed closely enough the few I had seen at work above ground to enable me to describe in exact detail the method by which they moved the dirt to form the familiar mounds. Lacking this information, I at first tried to acquire it in the easiest possible way, namely, by reading what others had written on the subject. After looking through a number of articles describing the method employed by the gopher in moving the dirt, I was surprised to find several accounts differing considerably from each other. I then set about getting the information from *Geomys bursarius* itself.

In order to secure these data, I constructed an observation box about two feet square and three inches in depth having one side of heavy plate glass. The box was set on edge and about half-filled with moist soil. A specimen of *Geomys bursarius*, which I succeeded in securing uninjured in a small steel trap, was placed in the box, where its actions,

both above and below the ground, could be observed through the glass. The little animal acted its part admirably and I was able to obtain a number of feet of motion pictures of its more interesting activities. The accompanying illustrations were drawn from motion picture prints.

The exact method, as I observed it, by which this animal loosened and moved the dirt along its tunnel was as follows. While digging, it braced itself on wide spread hind feet and clawed rapidly at the earth with powerful strokes of its fore feet directed downward and inward, thus piling up a small heap under its body. The right and left feet were used alternately, the performance reminding me very much of my small fox terrier trying vainly to dig a striped ground squirrel from its burrow. All of the actions of the pocket gopher were positive and energetically carried out, often to the point of the animal's appearing to be loosing its anger on the offending soil. Among such actions might be included the downward gouging of the ground with the upper incisors as an aid in more rapidly loosening the dirt for removal. This was not occasioned by any obstacle in the soil, as I had very carefully prepared the dirt for the experiment. Every few seconds the accumulated heap beneath the animal was vigorously moved back another step by a kick of the hind feet, both being used simultaneously. When about a large handful had been thus deposited back of the gopher, its next move was to turn around, and a very interesting move it was. Even while working in a tunnel that was apparently only large enough to comfortably accommodate it lengthwise, the gopher easily accomplished this movement by crouching, pulling in its head with the nose tucked downward between its hind feet, and slipping around with astonishing ease and rapidity. Then, pointing its nose out ahead and laying its chin on the little mound of loosened earth, it proceeded to form a tiny snow-plow effect with its fore paws, the pads almost together and the long claws curving horizontally outward. I might better say, like a tiny snow-plow in reverse, for the side wings of the plow formed by the animal's claws, curved forward and tended to keep the load together ahead of the gopher rather than to throw it to the sides. In this position the animal moved forward in short jumps, each pause allowing it to back up slightly and re-collect its load, the movement being much like the action applied to a push broom. Figure 1 shows the animal in this act. In this way the soil was shoved along the burrow and out onto the mound at the surface. Since this particular experiment, I have observed four other individuals at different points in southern Minnesota and Iowa, and their actions in accomplishing this task appeared identical.

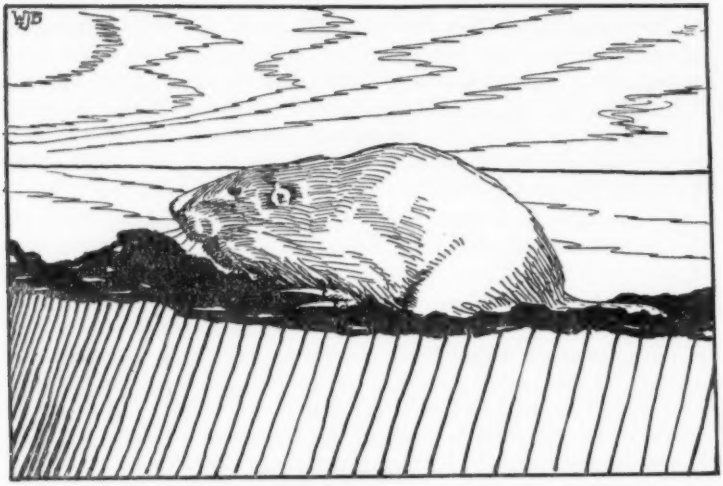


FIG. 1. POCKET GOPHER IN THE ACT OF MOVING DIRT

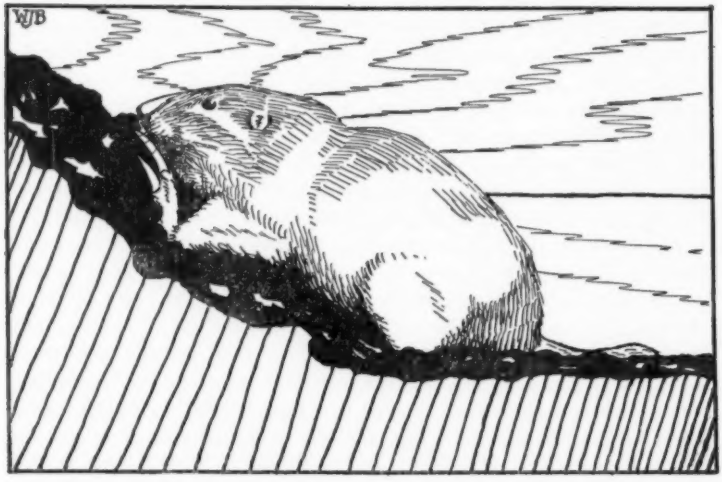


FIG. 2. POCKET GOPHER PACKING DOWN TRANSPORTED SOIL

Several other of the more interesting actions of the gopher might be cited. A number of writers have mentioned the fact that the gopher frequently plugs an opened hole so compactly that the plug is of the same density as the surrounding soil, and thus rendering it impossible for one to determine the direction of the tunnel. None of these authors, however, has stated just how this was accomplished. My little captive demonstrated admirably its method of doing this. When a load had been deposited at the desired point, the gopher shifted its hind feet back in order to throw as much weight as possible on its front paws and, with the long claws directed forward and the pads down, its forequarters appeared to bounce rapidly up and down and at the same time moved around over the loose soil till it was thoroughly tamped into place. Figure 2 illustrates the animal in this act.

Perhaps the most unusual attitude of the gopher was that assumed while it was sleeping. Crouching down and arching its back high, it brought its nose down between its hind legs, and came to rest bearing its weight upon its hind feet and the top of its broad flat head. It thus curled itself into a ball, as many other animals are described as doing, but in this case the circle rested vertically instead of horizontally. This position seemed to be rather unstable, as on several occasions I saw the animal roll over on its back as a result of its own restless shiftings while apparently sleeping. Probably, confined within the walls of its tunnel, however, it would experience little difficulty of this kind

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THE PHYLOGENY OF THE LEPORIDAE, WITH DESCRIPTION OF A NEW GENUS

By Lee R. Dice

The remains of fossil rabbits are scanty, and those specimens that have been found are often too fragmentary to determine satisfactorily the relationships with living forms. The bones of hares and rabbits are light in weight and fragile in structure, so that they are not easily preserved as fossils. Most of the species are inhabitants of uplands, where the conditions for preservation are poor. Further, being small in size, the bones of fossil rabbits are easily overlooked by collectors. In a few deposits rabbit remains seem to be fairly numerous, but many fossil species are known only from a few bones or teeth.

Imperfect as is our knowledge of the fossil members of the family, it seems desirable to organize the information at hand into a tentative grouping of the known living and fossil forms according to probable phylogenetic relationships.

As affording a clue to the phylogeny of the group, I believe the character of the enamel pattern of the first lower premolar (P_3) to be most useful. As the fossil species become better known, other correlated characters will undoubtedly be found. Very few fossil forms are known from complete skulls and, as usual in fossil mammals, the lower jaw is more likely to be preserved than the upper. The first lower premolar is probably known for more fossil species than any other part of the animal, and this makes the characters shown by this tooth very important.

On the basis of the character of the enamel folding of P_3, I propose to divide the family Leporidae into three subfamilies, each of which is presumed to indicate an independent phylogenetic series.

SUBFAMILY PALAEOLAGINAE, NEW NAME

Palaeolagida Haeckel, 1895, Syst. Phylogenie, part 3, pp. 502, 509 (in part).

Type genus.—*Palaeolagus* Leidy, Proc. Acad. Nat. Sci. Philadelphia, 1856, pp. 89–90.

Other included genera.—*Allolagus* new, *Pentalagus* Lyon, *Pronolagus* Lyon, and *Romerolagus* C. H. Merriam.

Characters of subfamily.—Main external reëntrant angle of the enamel on the face of P_3 not extending beyond the middle, and nearly meeting a strong internal reëntrant angle. The enamel pattern there-

fore forms a hour-glass-shaped figure, and the tooth is formed of two vertical columns of dentine, standing one in front of the other.

Palaeolagus from the Lower Oligocene to Upper Oligocene of North America is the earliest and most primitive known genus of rabbit or hare. In much worn stages P_3 of *Palaeolagus* may lose its internal reëntrant angle and the tooth thus come to resemble the corresponding

	PALAEOLAGINAE P_3	ARCHAEOLAGINAE P_3	LEPORINAE P_3
RECENT	Pentalagus Pronolagus Romerolagus		Brachylagus Caprolagus Lepus Oryctolagus Sylvilagus
PLEISTOCENE	Pronolagus	Hypolagus	Lepus Oryctolagus Sylvilagus
PLIOCENE	Allolagus	Hypolagus	Caprolagus
MIOCENE		Hypolagus	
OLIGOCENE	Palaeolagus	Archaeolagus	
EOCENE	Unknown ancestral leporids		

FIG. 1. OCCURRENCE OF THE GENERA OF RABBITS AND HARES ACCORDING TO GEOLOGICAL PERIODS

tooth of *Archaeolagus*. Matthew[1] has suggested that this condition in old teeth indicates the process by which *Lepus* has been evolved. It seems possible that the Leporinae and also the Archaeolaginae may have originated from the early Palaeolaginae, but the evidence from the fossils is too scanty to demonstrate this to be the case.

[1] W. D. Matthew, Bull. Amer. Mus. Nat. Hist., vol. 16, p. 306, 1902.

Allolagus new genus

Type species.—*Lepus annectens* Schlosser, Palaeontologia Sinica, ser. C., vol. 1, fasc. 1, p. 44. 1924.

Diagnosis.—Anterior lower premolar (P_3) "of two columns connected in the centre of the tooth by a bridge of dentine." Anterior upper premolar (P^2) without reëntrant angles on its anterior face. The figures given by Schlosser indicate that the reëntrant angles of the upper molariform teeth extend about the same distance across the teeth as in all modern genera of leporids. In *Palaeolagus* these reëntrant angles are more shallow. Further, no crenulation is shown by the figures in the reëntrant angles of either the upper or lower molariform teeth. Such a lack of crenulations would undoubtedly be a primitive character.

Judging from the description and figures given by Schlosser, *Allolagus* is nearest the genus *Palaeolagus*, but lacks the reëntrant angle on P^2; apparently the enamel crescents, which are present on the less worn molariform upper teeth of *Palaeolagus*, are also absent; and there is no indication of the posterior third lobe or heel characteristic of the younger stages of wear in the lower molariform teeth of *Palaeolagus*. *Allolagus* is known only from the one species, occurring in beds of Pliocene or late Miocene age in Mongolia.

Pentalagus is a modern genus of the subfamily Palaeolaginae restricted to the Liu Kiu Islands south of Japan. *Pronolagus*, another modern genus, is represented by three living species in south Africa, and is reported[2] fossil also in Pleistocene deposits of the same region. *Romerolagus*, a third modern genus, is known only from one species having a restricted range on the slopes of Mts. Popocatepetl and Iztaccihuatl in Mexico.

Although the subfamily Palaeolaginae contains the most primitive known genus of fossil rabbits, *Palaeolagus*, the modern genera are some of them highly specialized. *Pentalagus* has an extreme crenulation in the enamel pattern of all the grinding teeth, and the last upper molar is missing. *Pronolagus* also has a complex enamel pattern.[3] *Romerolagus*, on the contrary, has a rather simple type of enamel, which perhaps is correlated with the small size of the animal.

It should be noted that of the three modern genera of the Palaeolaginae: One has an island habitat; one is a relict restricted to a peculiar mountain habitat in Mexico; while only *Pronolagus* is fairly wide-

[2] H. L. Jameson, Ann. Transvaal Mus., vol. 1, p. 195, 1909.
[3] M. W. Lyon, Smithsonian Misc. Coll., vol. 45, pl. 91, 1904.

spread and abundant, though restricted to a more or less definite type of rocky habitat in south Africa. This discontinuous present distribution of the subfamily is corroborative evidence of its antiquity.

SUBFAMILY ARCHAEOLAGINAE, NEW NAME

Type genus.—*Archaeolagus* Dice, Univ. California Publ. Geol., vol. 10, p. 180, 1917.

Other included genus.—*Hypolagus* Dice.

Characters of subfamily.—No internal reëntrant angle on P_3 and main external reëntrant angle extending only about half-way across the tooth.

The genus *Archaeolagus* is known from one species in the Upper Oligocene John Day beds of Oregon.

Hypolagus ranges from the Middle Miocene to Middle Pleistocene in North America. Besides *Hypolagus vetus* and *H. edensis*, I place in this genus the species described as *Brachylagus browni* Hay,[4] *Lepus macrocephalus* Matthew,[5] *Lepus primigenius* Matthew,[5] and *Lepus giganteus* Brown.[6]

It is with some hesitation that I establish a subfamily on characters seemingly intermediate between those of the other two subfamilies of the Leporidae. However, no forms are known which clearly connect *Archaeolagus* and *Hypolagus* to either the Palaeolaginae or Leporinae. Also, *Hypolagus* seems to have persisted in North America long after the Leporinae had become established in the Old World. It therefore seems probable that *Archaeolagus* and *Hypolagus* represent an independent line of evolution which persisted over a fairly long period of geologic time in North America, but disappeared in the Pleistocene.

SUBFAMILY LEPORINAE, NEW NAME

Type genus.—*Lepus* Linnaeus, Syst. Nat., ed. X, vol. 1, p. 57. 1768.

Other included genera.—*Brachylagus* Miller, *Caprolagus* Blyth, *Oryctolagus* Lilljeborg, *Sylvilagus* Gray.

Characters of subfamily.—No internal reëntrant angle on P_3, and main external reëntrant angle extending completely across the tooth; no enamel crescents on upper molariform teeth.

Brachylagus with one species has a restricted distribution in the Great Basin region of western North America.

[4] Proc. U. S. Nat. Mus., vol. 59, pp. 630–631, 1921.
[5] Bull. Amer. Mus. Nat. Hist., vol. 23, pp. 214–216, 1907.
[6] Mem. Amer. Mus. Nat. Hist., vol. 9, p. 199, 1908.

Caprolagus is the earliest known fossil member of the subfamily, three species of the Pliocene of Europe and India being referred by Major[7] to this genus. Two living species are found in India, southern China and Formosa.

Oryctolagus, the European rabbit, occurs at the present time in Europe and North Africa, and is found fossil in the Pleistocene of Europe. Artificial introduction has carried it to Australia and to various islands.

Lepus has the most extensive range of all recent leporids, being widely distributed with many species and subspecies in Eurasia, Africa, and North America. It occurs fossil in the Pleistocene of Eurasia and North America.

Sylvilagus is at present distributed over much of South America and the southern half of North America, being represented by many species and geographic races. Pleistocene fossils are known both from North and South America.

The subfamily Leporinae is the dominant group of rabbits and hares of today, being native to all the continents except Australia. So far as known, it first appeared in the Pliocene of Eurasia as the genus *Caprolagus*. In North America and South America it is first known from the Pleistocene.

OTHER LAGOMORPHS

Panolax Cope is a leporid known only from a few teeth from the Upper Miocene of New Mexico. The first lower premolar has not been found and the relationships of the genus are uncertain.

Desmatolagus Matthew and Granger almost certainly belongs to the Ochotonidae,[8] and is very close to the genus *Oreolagus*.

Nesolagus Major, a rabbit living today in the Island of Sumatra, can not be placed in a subfamily at present because there is no description available of the enamel pattern of its first lower premolar.

Lepus primaevus Schlosser from the Pliocene of Germany is too imperfectly known to determine its generic affinities.

Numerous other fossils have been described under the heading *Lepus* sp., but from such scanty material or so incompletely described that no conclusions as to relationships can be drawn.

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[7] Trans. Linn. Soc. London, ser. 2, Zool., vol. 7, pp. 514, 517, 1899.

[8] See E. Stromer, In: E. Kaiser, Die Diamantenwüste Südwest Afrikas, vol. 2, p. 128, 1926.

LIST OF THE PUMAS, WITH THREE DESCRIBED AS NEW

By E. W. Nelson and E. A. Goldman

Since the "Preliminary Revision of the Pumas (*Felis concolor* Group)" by Merriam (Proc. Washington Acad. Sci., vol. 3, pp. 577–600, December 11, 1901) was issued no further attempt has been made to trace the relationships and geographic distribution of the components of the group as a whole. In the latest check list by Miller (List of North America Recent Mammals, 1923 [1924]) the North American forms alone were assigned to seven nominal species. This unsatisfactory status of the group has no doubt been largely due to the fact that it is only in recent years, and especially through the activities of the field force of the Biological Survey engaged in predatory animal control, that specimens were accumulated in sufficient number from any particular region to afford a reliable index to the constancy and comparative value of characters presented. A revision by the authors, based on practically all of the material available in North American collections is now well advanced. This material includes representatives of every known form except *Felis concolor söderströmii* Lönnberg. Complete intergradation can definitely be established in some cases and the kind and combination of characters presented indicate such close relationships that it can safely be assumed in the others. Our conclusion, already forecasted by some authors who have studied sections of the group, is therefore, that all of the members are properly assignable as geographic races, or subspecies, of *Felis concolor* Linnaeus.

Pending the completion and issuance of a comprehensive treatment of the group it seems desirable to publish a revised list of the forms, with type localities. In order to complete this with greater precision it becomes necessary to fix the type localities of *Felis concolor* Linnaeus and *Felis puma* Molina, which were left very indefinite by their authors. *F. concolor* was assigned by Linnaeus to "Brassilia." Merriam (l. c.) gave the type region as probably southeastern Brazil, and he used a skull from Piracicaba, not far from São Paulo, as a basis for comparison. The vicinity of the city of São Paulo is designated by us as the type region, specimens from Piracicaba being considered as typical. *F. puma* was described by Molina from "Chili," a country which in his time extended north as a narrow strip ending at latitude 24°. Merriam (l. c.) regarded a young individual from Santiago as representative, and we select the vicinity of that centrally located place as the type region.

The type of *Felis arundivaga* Hollister (Proc. Biol. Soc. Washington, vol. 24, p. 176, June 16, 1911) from 12 miles southwest of Vidalia, Concordia Parish, Louisiana, and other specimens from the same state, have been carefully compared with a larger number of typical *Felis coryi* Bangs (Proc. Biol. Soc. Washington, vol. 13, p. 15, January 31, 1899) from Florida than was available for study by the describer. We have been unable to find any distinctive characters and the former name seems to belong in the synonymy of the latter. *Felix* [sic] *oregonensis* was described by Rafinesque (Atlantic Journal, vol. 1, no. 2, p. 62, June 20, 1832), no definite locality being given, but indirect reference was made to "the western wilds of the Oregon mountains, or east and west of them." There seems to be no doubt that the describer referred to a member of the group ranging in the region near the northwest coast of the United States, as pointed out by Stone (Science, n.s., vol. 9, p. 35, January 6, 1899). Our studies indicate that a widely distributed form to which Rafinesque's name is applicable occupies the coastal region from Vancouver Island, British Columbia, to southern Oregon, and *oregonensis*, therefore, has precedence over *Felis hippolestes olympus* Merriam (Proc. Biol. Soc. Washington, vol. 11, p. 220, July 15, 1897), from Lake Cushman, Olympic Mountains, Washington.

For the privilege of examining almost indispensable material our thanks are due to Dr. Thomas Barbour, director, Museum of Comparative Zoology; to S. C. Simms, director, and Dr. Wilfred H. Osgood, curator of zoology, Field Museum of Natural History; to H. E. Anthony, curator of mammals, American Museum of Natural History; to Dr. Joseph Grinnell, director, Museum of Vertebrate Zoology; to Dr. A. Avinoff, director, Carnegie Museum; to Dr. Charles C. Adams, director, New York State Museum; to C. D. Bunker, assistant curator of birds and mammals, University of Kansas, and to Prof. George Wagner, chairman of the department of zoology, University of Wisconsin.

The recognizable subspecies assigned to *Felis concolor*, with type localities, are as follows:

Felis concolor concolor Linnaeus . . . Vicinity of São Paulo, Brazil.
Felis concolor pearsoni (Thomas) . . . . . Santa Cruz, Argentina.
Felis concolor patagonica (Merriam)
Lake Pueyrredon, Argentina.
Felis concolor puma (Molina) . . . . . Vicinity of Santiago, Chile.
Felis concolor incarum, subsp. nov.
Piscocucho, Rio Urubamba, Peru.

Felis concolor osgoodi, subsp. nov.
Buena Vista, Santa Cruz, Bolivia.
Felis concolor söderströmii Lönnberg
Nono, Mount Pichincha, Ecuador.
Felis concolor wavula Lesson.....Demerara, British Guiana
Felis concolor bangsi (Merriam).....Dibulla, Colombia.
Felis concolor costaricensis (Merriam)
Boquete, Chiriqui, Panama.
Felis concolor mayensis, subsp. nov.
La Libertad, Peten, Guatemala.
Felis concolor azteca (Merriam)
Colonia Garcia, Chihuahua, Mexico.
Felis concolor coryi (Bangs)
Wilderness back of Sebastian, Florida.
Felis concolor couguar (Kerr).....Pennsylvania.
Felis concolor improcera (Phillips)
Calmalli, Lower California, Mexico.
Felis concolor browni (Merriam)
Colorado River, 12 miles south of Yuma, Arizona.
Felis concolor californica (May)...Upper Kern River, California.
Felis concolor hippolestes (Merriam)
Wind River Mountains, Wyoming.
Felis concolor oregonensis (Rafinesque)
Northwest coast region of the United States.

DESCRIPTIONS OF NEW SUBSPECIES

Felis concolor incarum[1] subsp. nov.

INCA PUMA

Type.—From Piscocucho, Rio Urubamba, Department of Cuzco, Peru (altitude 8,700 feet). No. 194310, ♂ adult, skin and skull, U. S. National Museum, collected by Edmund Heller, July 22, 1915. Original number 566.

General characters.—A medium sized, dark colored, well furred, high mountain animal with skull characterized by the combination of a broad frontal region, with posteriorly attenuate nasals, remarkably narrow interpterygoid fossa, small auditory bullae and rather slender canines. Similar in general to *F. c. puma* of central Chile, but color strongly inclining toward dark tawny instead of gray, and cranial characters distinctive. Compared with typical *F. c. concolor* the rich rufescent coloration of latter is lacking and skull differs widely in detail.

Color.—Type: Top of head, neck, and median dorsal area to base of tail near tawny of Ridgway, moderately darkened by black-tipped hairs; sides of body and outer surfaces of limbs dull cinnamon, becoming cinnamon buffy on feet;

[1] From Inca the name of the Indian race inhabiting the region of the type locality.

chin and throat nearly pure white; inner sides of limbs and inguinal region dull white, the dark basal color showing through; chest and belly pale cinnamon; middle of face buffy grayish; facial markings as usual in the group, the upper lips white near sides of nose, and areas at base of vibrissae distinctly blackish; ears blackish externally, thinly clothed internally with light buffy hairs; hairs around pads on feet blackish, tail above dull tawny mixed with black, becoming dull ochraceous tawny below, to near tip which is black, the black extending forward about three inches on upper side.

Skull.—Similar to that of *F. c. puma*, but somewhat smaller, less massive; nasals narrower, more evenly tapering to a nearly acute point posteriorly (broader and obliquely pointed in *puma*); palate and interpterygoid fossa much narrower; jugal less extended posteriorly; basioccipital much less deeply excavated for muscular attachment; auditory bullae smaller; dentition lighter, the canines notably more slender, and second upper premolars narrower; upper sectorial with inner cusp moderately developed about as in *puma*. Contrasted with that of typical *F. c. concolor* the skull is similar in size, but heavier; rostrum broader; nasals flatter, less strongly decurved along inner margin anteriorly, the posterior ends narrower and pointed instead of evenly rounded; frontal region broader and flatter, with postorbital processes longer, less decurved; interpterygoid fossa much narrower; jugal less extended posteriorly; basiooccipital less excavated for muscular attachment; auditory bullae much smaller, less inflated, less broadly attached to exoccipitals posterioriy; dentition heavier, the second upper premolar decidedly larger, and upper sectorial with a more prominent inner cusp.

Measurements.—Type: Head and body, 1220 mm.; tail vertebrae, 685. *Skull* (type): Greatest length, 206; zygomatic breadth, 141.8; interorbital breadth, 42.8; least width between outer walls of interpterygoid fossa, 26.2; alveolar length of upper canine-premolar series, 62.2; alveolar length of upper carnassial, 22.1.

Remarks.—No specimens of *F. c. söderströmii* another high mountain form, described from the Andes about 1,000 miles farther north, have been available for comparison with *F. c. incarum* and the exact relationship of the two remains to be determined. Lönnberg's description, however, indicates that *söderströmii* is a much smaller, still darker-colored animal with distinctive cranial characters, especially the "pinched in" nasals, and large upper carnassial. The type of *incarum* was examined and referred by Thomas to "*Felis puma*" without comment (Proc. U. S. Nat. Mus., vol. 58, p. 223, 1921). It should be understood, however, that the author mentioned was not making any extended studies of the group.

Specimens examined.—Four, from localities as follows:

PERU: Piscocucho (type locality), 1; La Lejia, 1; without locality, 2 (1 skin only and 1 skull only).

Felis concolor osgoodi[2] subsp. nov.

BOLIVIAN PUMA

Type.—From Buena Vista, Department of Santa Cruz, Bolivia. No. 25256, ♂ adult, skin and skull, Field Museum of Natural History, collected by Jose Steinbach, June 10, 1924. Original number 1463.

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[2] Named for Dr. Wilfred H. Osgood, curator of zoology, Field Museum of Natural History, in recognition of his important field and laboratory studies, with special reference to the mammals of South America.

General characters.—A medium-sized, short haired, rich reddish form with a low, flattened skull. Closely allied to typical *F. c. concolor*, but distinguished by cranial features. Similar in general to *F. c. incarum*, but color much more reddish, pelage shorter, thinner, harsher, and skull differing in detail.

Color.—Type: Top of head, neck, and narrow median dorsal area to base of tail rusty reddish, or near cinnamon rufous of Ridgway, somewhat obscured by overlying black tips of hairs, the general tone shading through dull pinkish cinnamon to cinnamon-buff of Ridgway on sides of body and outer surfaces of limbs, becoming gradually paler on feet; cheeks, chin and throat nearly pure white; inner sides of limbs and inguinal region dull white; chest and belly pale cinnamon-buff; middle of face dull clay color; upper lips white near sides of nose; areas at base of vibrissae cinnamon-buff, interrupted by several narrow but distinct, transverse, black lines; ears blackish externally, thinly clothed internally with light buffy hairs; hairs around pads on feet light brownish; tail above light cinnamon mixed with black, becoming cinnamon-buff below to near tip which is black, the black extending forward about two inches on upper side.

Skull.—Similar to that of typical *F. c. concolor*, but lower and flatter; frontal region less arched; postorbital processes less decurved; nasals flatter, less strongly decurved along median line anteriorly, the median groove comparatively shallow (median groove deep, and narrow V-shaped in *concolor*); interpterygoid fossa narrower; auditory bullae smaller, less inflated; dentition much as in *concolor* but internal cusp of upper carnassial more prominent. In general form the skull rather closely resembles that of *F. c. incarum*, but is somewhat smaller and lighter; nasals broader, more blunt posteriorly (slender and evenly tapering to point in *incarum*); interpterygoid fossa broader; auditory bullae larger; dentition lighter, canines decidedly more slender.

Measurements.—Type: Head and body, 1310 mm.; tail vertebrae, 710; hind foot, 280. *Skull* (type): Greatest length, 200; zygomatic breadth, 133.5; interorbital breadth, 40.7; least width between outer walls of interpterygoid fossa, 29; alveolar length of upper canine-premolar series, 58.3; alveolar length of upper carnassial, 20.9.

Remarks.—Intermediate in geographic position, *F. c. osgoodi* combines some of the characters of typical *F. c. concolor* of southeastern Brazil and *F. c. incarum*, the Andean animal inhabiting southern Peru. It has the rich, reddish coloration common to lowland forms of northern and eastern South America along with cranial characters indicating gradation toward the plainer colored Andean subspecies mentioned. The blending of characters presented in this case are a part of the general evidence that all of the pumas are referable to geographic races of a single species; and yet *osgoodi* differs from the other races sufficiently in the sum of its characters to warrant separate recognition by name. Specimens from Puerto Suarez, extreme eastern Bolivia, and from Corumba and Descalvados, just across the Brazilian boundary are referred to *osgoodi*, but in cranial details, especially the rather wide interpterygoid fossa and large inflated auditory bullae in the Brazilian examples, show an approach to typical *concolor*.

Specimens examined.—Seven, from localities as follows:

BOLIVIA: Buena Vista (type locality), 3, Puerto Suarez, 1.

BRAZIL: Corumba, 1; Descalvados, 2 (1 skin only).

Felis concolor mayensis[3] subsp. nov.

GUATEMALAN PUMA

Type.—From La Libertad, Department of Peten, Guatemala. No. 244856, ♂ adult, skin and skeleton, U. S. National Museum (Biological Survey collection), collected by Harry Malleis, August 22, 1923. Original number 465.

General characters.—A small tawny or reddish subspecies. Closely related to *F. c. costaricensis*, but smaller, dorsal area paler, less ferruginous or deep rusty reddish, and skull differing in detail, especially the peculiar form of the nasals, and the shorter postorbital processes. Also allied to *F. c. azteca* but decidedly smaller, color richer, more rufescent; skull smaller and presenting other differential features, notably the slenderness of the nasals and of the canine teeth.

Color.—Type: Top of head, neck, and narrow median dorsal area to base of tail between tawny and ochraceous tawny of Ridgway, richest along rump, slightly darkened by black tips of hairs, the general tone paling to light ochraceous buff on sides of body and outer surfaces of limbs; inner sides of limbs and inguinal region dull white; chin and throat nearly pure white; under side of neck light ochraceous buff; chest and belly dull whitish, with a few irregular ochraceous buffy markings; middle of face buffy grayish, mixed with ochraceous tawny; areas at base of vibrissae blackish; ears brownish black externally, thinly clothed internally with whitish hairs; tail above ochraceous buffy, heavily overlaid with black along narrow median line of distal half, becoming lighter buff below to near tip which is black, the black extending forward about two inches on upper side.

Skull.—Similar to that of *F. c. costaricensis* but smaller; rostrum less flattened; nasals narrower, the inner margins more strongly decurved along median line anteriorly, the upper outline more convex or abruptly expanded upward at a point about one-third distant from posterior ends; postorbital processes decidedly shorter; interpterygoid fossa broader; dentition similar, but upper sectorial with inner cusp more prominent. Compared with that of *F. c. azteca* the skull is decidedly smaller and lighter in structure; nasals much narrower; interpterygoid fossa narrower; dentition lighter; small anterior premolar nearly filling space between canine and second premolar (anterior premolar in *azteca* with a distinct gap before and behind).

Measurements.—Type: Total length, 1710 mm.; tail vertebrae, 660; hind foot, 240. *Skull* (type): Greatest length, 183; zygomatic breadth, 127.7; interorbital breadth, 37.7; least width between outer walls of interpterygoid fossa, 26.7; alveolar length of upper canine-premolar series, 55.4; alveolar length of upper carnassial, 20.6.

Remarks.—F. c. mayensis is the smallest of the North American members of the group. While most closely allied to *F. c. costaricensis* it combines the rufescent type of coloration and delicate structure of that and some other tropical forms with the short postorbital processes, rather wide interpterygoid fossa and other cranial features characterizing the more northern and plainer-colored *F. c. azteca*.

Specimens examined.—Five from localities as follows:
GUATEMALA: La Libertad (type locality), 3 (1 skin only).
VERA CRUZ: Catemaco, 2 (skulls only).

U. S. Biological Survey, Washington, D. C.

[3] From Maya, the name of the Indian race inhabiting the region of the type locality.

GENERAL NOTES

THE VIRGINIA OPOSSUM IN OREGON

During the past few years, the presence of opossums in Umatilla County, Oregon, has been known to the writers but no investigation had been made until recently to ascertain the extent of their range, what form occurred, and how they came to be introduced so far away from their natural habitat.

Recent investigation by Harold Dobyns of the U. S. Biological Survey has resulted in some interesting information concerning these animals. One specimen was collected on September 9, 1928, and forwarded to the Biological Survey collection. This proved to be typical *Didelphis virginiana virginiana*.

The information so far obtained shows records of at least four opossums being brought into Umatilla County as pets and that these escaped or were liberated during the period between 1910 and 1921.

Sam Walker, an old pioneer of the McKay Creek district, told us that a man by the name of Wade, who had a ranch adjoining him on McKay Creek and who has since moved away, liberated a pair of opossums there fifteen years or more ago. Mr. Walker also stated he had one for a pet and that it escaped about the same time. It is thought that these are the first opossums known to have been liberated in this section and the ones that furnished the basis for the present opossum population. L. E. Roy, of Pilot Rock, informed us that about seven years ago an opossum was sent to him from Oklahoma for a pet and that it escaped. He did not remember whether it was a male or female.

During the past six or seven years, fur trappers operating along McKay and Birch creeks and tributaries have taken opossums in traps set for minks and skunks. We have knowledge of fifty or more opossums being taken along McKay Creek from the McKay Creek reservoir to the mouth of Johnson Creek, a distance of about twenty-two miles. During the trapping season of 1927–28, at least twelve opossums were taken by local trappers within a distance of about five miles along lower McKay Creek. One was also taken on Birch Creek below Pilot Rock. Besides the specimen collected by Mr. Dobyns, another immature male was captured and liberated, and still another made away with a trap.

The exact extent of their present range is not known, but in addition to McKay and Birch creeks we have noted signs of them along the Umatilla River above Pendleton. There are also unverified reports of the species being present along the Walla Walla River above Milton.

From information so far obtained, we would say they were fairly well established and thriving very well for an animal so far away from its natural environment.—Stanley G. Jewett and Harold W. Dobyns, *U. S. Biological Survey, Portland, Oregon.*

CALIFORNIA MINK IN MARINE HABITAT

On the coast of California, north of San Francisco Bay, minks occur commonly in fresh-water streams and in brackish water in estuaries but, previous to the instance here recorded, none is known to have been taken along the mentioned coast in the ocean proper. It was, therefore, with much surprise that James

Moffitt and the writer noted a mink on the farthest outlying rocks at the extreme tip of Tomales Point, Marin County, California, at 2:30 p.m. on May 6, 1928.

The peninsula which includes Tomales Point is sixteen miles long and in the terminal five miles has a maximum width of one and one-fourths miles. The peninsula separates Tomales Bay from the Pacific Ocean, and the land is only a few feet wide at the tip. There are no streams on the peninsula, along which a mink would be expected to occur, nearer than six and three-fourth miles to the point proper. The vegetational cover of the outlying part of the peninsula is low growing. Chaparral, bracken, and a dense growth of grasses and low weeds make up the flora.

When first seen, the mink ran across the top of one of the large rocks exposed five or six feet above the water. From our vantage point on the sea cliff, Moffitt fired a charge of shot into the crevice where the mink had fled and it soon came out and dived into the swirling water of a channel among the rocks. Two more shots, when the mink came to the surface, were necessary to make a kill. Moffitt's Irish terrier retrieved the animal which was an old male. Although in good physical condition the mink was not fat. It weighed 1220 grams. The digestive tract was empty and gave no clue as the the type of food utilized.

The fact to be emphasized about this occurrence is that an individual of *Mustela vison aestuarina*, a subspecies of fresh-water and terrestrial habitat, here appeared in a typical marine habitat and at a considerable distance from any seemingly suitable fresh-water environment.

On a later visit to Tomales Point, Moffitt was told by a local fisherman that minks were occasionally, though not commonly, to be seen among the boulders of the sea cliff.—E. Raymond Hall, *California Museum of Vertebrate Zoology, Berkeley, California.*

AN UNUSUALLY LONG-TAILED WHITE-FOOTED MOUSE

While collecting mammals at Clinton, Connecticut, during the summer of 1928, I was puzzled by the capture of an unusually long-tailed specimen of *Peromyscus leucopus noveboracensis*. This white-footed mouse, measured in the flesh, has a tail length of 90 mm., with a total length of 180 mm., and hind foot, 21 mm. Unfortunately, the specimen was taken during a stormy night, and the shrews had helped themselves liberally to the viscera and had eaten through the vertebrae.

However, the skin was intact on the back but undoubtedly stretched when measured, which makes the tail, relatively, still longer. At first glance I took this individual to be *maniculatus*, as the tail length would suggest, but on closer examination the tail, though long, has otherwise all the characters of typical *noveboracensis* and the skull removes all doubt as to its identity. The specimen was taken at the side of a stone wall in an open field.—G. G. Goodwin, *American Museum of Natural History, New York, N. Y.*

LIFE HISTORY NOTES ON SIGMODON HISPIDUS HISPIDUS

Cotton rats (*Sigmodon hispidus hispidus*) are very common throughout the southern coastal marsh region of Louisiana. Their numerous labyrinthine runways are found almost everywhere under the thick matted grasses. It is not uncommon to see them either scurrying through the grasses or across the road.

They are also very abundant in the cane fields and truck gardens, where they feed chiefly upon the crops. Were it not for the fact that large areas of this region are still wild and uncultivated, cotton rats would be serious pests to the farmers. However, their natural enemies, snakes, owls, hawks, and carnivorous mammals, play an important part in controlling them. In this damp, marshy habitat they fill the place that *Microtus* does in the north.

On ridges somewhat higher than the surrounding marshes, their nests, made of grasses, have been found in slight depressions along their runways or in the protection of overhanging thistle leaves. In these grassy nests I have found young numbering from three to six in a litter.

Audubon and Bachman (Quadrupeds of North America, vol. 3, p. 231, 1847) say that this rodent "is very prolific, producing young early in spring, and throughout the summer months till late in the autumn. They produce from four to eight at a litter." The young they raised in captivity "were of a bright chestnut-brown colour, and at the age of five or six days begin to leave the nest." My observations agree with this, as I have found either pregnant females or young during February, April, July and August.

The young raised in captivity were covered with hair "of a bright chestnut-brown colour" as the above authors have stated, although they neglected to say that the young were also born hairy. The young weighed from 6.5 grams to 8 grams at birth, the average weight of nineteen being 7.23 grams. The young are large and well developed at birth, being able to run about very well, though their eyes are still unopened. Within twenty-four hours after birth, the eyes open and the young are able to run about more energetically than when first born. The number in a litter varied from three to six, with an average of 4.75. The mammae, eight in number (pectoral 2-2, inguinal 2-2), are clearly visible on the ventral surface of the young females. The young grow very rapidly, gaining in weight about a gram a day. When about ten days old they are weaned and are able to feed upon such hard foods as sweet corn.

When captured and handled, cotton rats show their displeasure by loud squeaking noises.

Owls have been known to feed upon cotton rats. Five out of eight barn owl pellets from this region consisted chiefly of cotton rat remains. Alligators have been examined by the author, and also have been found to feed on cotton rats. In captivity, minks and raccoons were fed cotton rats, and there is every reason to believe that they also feed upon them in nature, thus assisting in keeping these rapid growing, prolific rodents in check.—ARTHUR SVIHLA, *University of Michigan, Ann Arbor, Michigan.*

THE WORD "CARIBOU"

Prof. L. B. Walton's suggestion (Science, n.s., vol. 68, p. 352, 1928) that *caribou* comes from *carreboeuf* (four-horned ox) is a very strong case if one consult the reference he gives (Allerton edition 1801, p. 209; the edition of 1801 of London consulted by this writer, pp. 13, 14). But Sir Alexander Mackenzie in 1789 and 1793, like many Britishers, in his "Voyages" (1801 edition, pp. 12, 13, 14, 38, 44, 45, 70, 97, 99, 106, 150, 205, 209) used the English equivalent of *caribou*, namely, *reindeer*. The only time he uses *carreboeuf* is in the instance Professor Walton

indicates. His derivation for *caribou* may be correct, but we incline to an Indian origin. The European equivalents of *renne, tarandus*, and *rennthier* for *reindeer* not being used, we suspect that some other Indian name than *attenk* or *attehk* (Cree), *tuktu* (Greenlanders), *tooktoo* (Esquimaux), *atick* (Algonquin), *attick* (Knisteneaux), *see-hah* and *tangkah* (Sioux), *edthun* or *etthin* (Chepewyan), *et-then* (see Pike 1892), *la foule* (Yellow Knife Indians), *tantseeah* (Copper Indians), gave this American reindeer its name. Furthermore, Mackenzie's *carreboeuf* comes 185 years after the first use of *caribou*.

The earliest English explorers, such as John Cabot (1497), Sir Humphrey Gilbert (1576), Martin Frobisher (1576), George Best (1578), John Davis (1585), M. Hore (1536), M. A. Parkhurst (1578), George Peckham (1783), Sylvester Wyet (1594), and others from 1500–1600, do not mention *caribou*. Some of their *stags* are no doubt *caribou*. Jacques Cartier (1535–1540) did not use the word *caribou*.

If one consult the Jesuit Relations, such as those of 1610–1613, or Biard's *Relation* of 1616, one finds *caribous*. This appears several times as *les caribous* (1647) or *aux caribous* (1651–52, 1653–54). Biard's *Relation* of 1616 has "the *caribou* (*caribous*), an animal half ass and half deer." This also appears as *cariboux* (1671–72) or *de cariboux* (1659–60). *Le caribou* (1720–36, 1635) may appear as a collective noun or singular noun. We also have *un caribou* (1645–46, 1651–52), or *de caribou* (1642, 1650–51, 1710–1756). In one case (Marest, 1695) it has the Latin form of *caributorum* and *caributus*. In Le Jeune's *Relation* (1634), the original for *caribou* is *caribōs*. The excerpt is "*Caribou*, by some called the wild ass." The *Relations* of 1663–64 give *de caribouds*.

Charlevoix (1743) first speaks of *caribou* under the year 1611 (see Jesuit Relations, 1610–1613) and the very first mention of *caribou* we find in *Hakluytus Posthumous*, vol. 18 (for New France, 1604), p. 273. This also has *carabous*. Or the first record may be Marc Lescarbot (1609). Champlain in *Voyage* of 1611 speaks of *caribous*. The editor of the Prince Society volume writes that "Champlain employs the names of the different species of the Cerf family as used in Europe; (Cerfs, Daims, Chevreuls, Caribous) but as our species are different this use of names creates some confusion." I fear he should have omitted *caribous* as European.

Caribou and *caribous* are frequent in use. The former was used by Jeffery (1760), Heriot (1807), Warburton (1829), Alexander Henry (1800), Buckingham (1892), and many others. Today it is the prevalent vogue. G. Sagard [*Hist. du Canada* (to 1615), 1636, p. 750] calls this animal "des *caribous*, ou asnes sauvages, que quelqu'uns appellent Ausquoy à mon aduis, ..." The second form, the plural *caribous*, occurs frequently: Charlevoix (for 1669) (1743), Heriot (1807), J. Long (1791) (*reinder* skins, English; *caribous*, French). The form *cariboux* remains in *Lac aux cariboux*, or *cariboux skins* (Henry and Thompson Journals, about 1808). Timothy Flint (1832) varies it to *coribou*.

From 1807 to 1863, *cariboo* or *cariboos* is frequent, as used by Heriot (1807), Morse (1822), Haliburton (1829), Bouchette (1832), Shoolcraft (1834), Martin (1837), Jameson (1839), "Eighty Years' Progress Canada" (1863). Several of these give appositives, such as, a species of reindeer, American reindeer, reindeer. Some may vary it to *caribo* (Godley, 1844) or *carriboo* (Ruysdale, 1854), or *caraboo*

deer (George Head, 1829), or *rynd* or *keraboo* (P. Campbell, 1793). J. Carver (1766) varied from *carraboo, caraboe, carraboe,* to *carraboes.*

Thus the variants are *caribou, caribous, cariboux, caributus, caribos, caribouds, carabous, coribou, cariboo, carriboo, keraboo, caraboo, carraboo, carraboe, carreboeuf.*

The case for *xalibu* (the pawer) is not so insufficient as perfunctory dictionaries necessarily record. Alice F. Fletcher (Handbook of American Indians, 1907, part I, p. 206) summarizes it as follows:

"*Caribou.* The common name of the American reindeer, of which there are two chief species, the woodland caribou (*Rangifer caribou*) and the barren ground caribou (*Rangifer arcticus*). The word came into English from the French of Canada, in which it is old, Sagard Théodat using it in 1632. Josselyn has the Quinnipiac from *maccarib* and the synonym *pohano.* The origin of the word is seen in the cognate Micmac *Xalibu* and the Passamaquoddy *Megalip,* the name of this animal in these eastern Algonquian dialects. According to Gatschet (Bull. Free Mus. Sci. and Art., Phila. II, 191, 1900) these words signify 'pawer' or 'scratcher,' the animal being so called from its habit of shoveling the snow with its forelegs to find the food covered by snow. In Micmac *Xalibu mul-xadéget* means 'the caribou is scratching or shoveling.' Formerly the word was often spelled *cariboo,* which gave the name to the Cariboo district in British Columbia, ...

"*Caribous.* Wood in 1769 (Hawkins, *Missions,* 361, 1845) speaks of the 'Micmacs, Marshites (Malecite), and the Carribous, the three tribes of New Brunswick,' as all understanding the Micmac language."

On the strength of Josselyn's 1672 account, Seton apparently assigns it as "*Caribou,* the New England Indian name." He refers to John Josselyn's description in "New England Rarities." "*The Maccarib.* The *Maccarib, Caribo,* or *Pohano,* a kind of Deer, as big as a Stag, round hooved, smooth hair'd and soft as silk; their Horns grow backwards along their backs to their rumps, and turn again handful beyond their Nose, having another Horn in the middle of their Forehead, about half a yard long, very straight, but wreathed like an *Unicorn's* Horn, of a brown jettie colour, and very smooth: The Creature is no where to be found, but upon Cape Sable in the French quarters, and there too very rarely, they being not numerous. Some few of their skins and their straight Horns are (but very sparingly) brought to the *English.*" In his *Voyages,* Josselyn repeats they are found only around French plantations.

Another interpretation such as that of Marcus Petersen (1914, p. 345) is about 100 years old. He gives the following: "The word *Caribou* applied to the American Reindeer, is a contraction or corruption of the name 'caire boeuf'—a square ox—given this animal by the French Canadians, when it was first discovered in America." Sir John Richardson (1854, p. 20) speaks of "reindeer . . . . , all passing under the French Canadian appellation of *Carriboo* (*Quarré boeuf*), derived from the size of their antlers." Seton (1909, p. 191) writes "Why large antlers should constitute a *square ox* is a puzzle, and why the adjective should be transposed in this case is another. We can only regret that Richardson, usually so reliable, should have made the mistake of recording a *post hoc* and absurd explanation."

In another place Richardson (1829, vol. 1, p. 238) uses the expression *carrèboeuf,* or *caribou.* This is the only instance we know of anyone using *carreboeuf,*

except Mackenzie. The latter uses it almost two hundred years after the use of *caribou* began and Richardson's employment of it is 220 years afterwards.

Strangely enough the Micmac evidence accords with the facts that the missionary Biard (1611–1616) gave one of the best first accounts of the Micmacs and also is one of the first to use *caribou*. Quite certain it seems that it is "a native American word—the Indian name of the animal" (Seton) not of New England, but rather of New Brunswick, Nova Scotia, or Newfoundland. "In these points of view the *caribou* as it is termed by the Canadian Voyageurs" (E. T. Bennett, 1830, p. 249) doubtless received its name from *xalibu, the pawer*, rather than from *carre-boeuf, four horned ox*, or *quarre-boeuf, square ox*.—A. H. WRIGHT, *Ithaca, New York*.

MISLEADING NEWS REGARDING THE WISENT

The news that came from Russia a few months ago that a recent Russian expedition into the protected territory of the wisents in the northwestern Caucasus, where about twenty-five of the animals are supposed to have been seen in 1924, could not ascertain the whereabouts of any of them, has led many to believe that the final extinction of the wisent is near.

This erroneous opinion should not be spread. The International Association for the Preservation of the Wisent (Internationale Gesellschaft zur Erhaltung des Wisents), founded in 1923 with its domicile at Frankfort a. M. Zoological Gardens, desires to state that the few Caucasian wisents, a local form that differs in many respects from the Lithuanian, would never have been considered for breeding purposes in order to preserve this species, as the export of any captured wisent would have met with unsurmountable difficulties in Russia.

The above association, representing more than twenty European, Asiatic, and American countries, and including all owners of wisents, endeavors to preserve this largest European land mammal, the most precious and oldest game of our continent, by absolute *pure breeding*. Since two years ago a considerable number of animals has had to be taken off the breeding register, as careful examinations proved that they were not pure blooded. The association now records in various European game parks and zoological gardens more than sixty pure-blooded wisents in the best condition. These happily are of such different blood and their relationship is so favorable that the considerable hopes the association cherishes for attaining its goal seem to be justified.—ERNA MOHR, Archivarin der Internationalen Gesellschaft zur Erhaltung des Wisents, *Zoologische Museum, Hamburg 1, Germany*.

BAIRD'S BEAKED WHALE AT SANTA CRUZ, CALIFORNIA

On June 4, 1925, the newspapers of Santa Cruz and San Francisco, California, apprised the public of the occurrence of a sea serpent, or other more or less fabled marine monster, in Californian waters. A few days prior to the appearance of the newspaper stories, the remains of a large marine animal had been washed ashore on the beach at Santa Cruz, California. Decomposition had set in, and close examination of the carcass was not lightly undertaken. Consequently, the tales were the result of distant and hasty examination. When the news of the presence of this creature reached Dr. Barton Warren Evermann, director of the Museum

of the California Academy of Sciences, he visited the spot and pronounced the "sea serpent" to be the eviscerated carcass of a beaked whale. More specific identification was impossible at that time, but arrangements were made to have the skull preserved and it is now incorporated in the collections of the California Academy of Sciences.

Examination of the skull after its arrival at the museum proved it to be that of the rare Baird's beaked whale (*Berardius bairdii* Stejneger), previously known to science by only ten specimens. Of these ten specimens, two were taken in Tokyo Bay, Japan;[1] four on Bering Islands; two on St. George Island, Pribilof Group; one at Centerville Beach, near Ferndale, Humboldt County, California; and one is from an unknown locality.[2] Photographs of a small cetacean taken at Kiska Harbor, Alaska,[3] apparently are of an example of *Ziphius cavirostris*,[4] and an unsubstantiated take at Trinidad, California, is only doubtfully included by True[5] in his list of *Berardius bairdii* occurrences. Records of the California Sea Products Company state that a male of this species was secured in Monterey Bay, California, on October 1, 1920, but no part of the animal was preserved.[6] The skull in the Academy collection, therefore, not only increases the number of known examples, but, also, forms the basis of the most southerly authenticated record of occurrence of this species.

When the skull reached the museum, the tips of the mandibles had been broken off, and one pterygoid and the teeth were missing; otherwise it was in good condition. From the skull the following measurements, in millimeters, were obtained:

Total length	1515
Height from vertex to inferior border of pterygoid	540
Breadth across middle of orbits	790
Breath across postorbital processes	820
Breadth across zygomatic processes	790
Length of rostrum	960
Breadth of rostrum at base	450
Breadth of rostrum at middle	205
Breadth of premaxillae at middle	125
Greatest breadth of premaxillae in front of nares	240
Greatest breadth of premaxillae behind nares	235
Distance from anterior end of premaxillae to posterior end of pterygoids (median)	1150
Distance from anterior end of premaxillae to anterior end of vomer	135
Length of vomer visible on palate	420
Length of nasals (median)	195

[1] Andrews, Science, n.s., 36, 1912, p. 903.

[2] True, Bull. U. S. Nat. Mus., no. 73, pp. 60–61.

[3] True, Bull. U. S. Nat. Mus., no. 73, p. 77; Miller, Bull. U. S. Nat. Mus., no. 128, p. 514.

[4] A. J. Poole, in letter.

[5] Bull. U. S. Nat. Mus., no. 73, p. 2.

[6] Identified by Captain Dietrich, an old whaler. I am indebted to Doctor Evermann for the information.

Greatest breadth of nasals	145
Breadth of anterior nares	100
Breadth of foramen magnum	90
Breadth across occipital condyles	250
Breadth of each condyle	110
Height of each condyle	195

Measurements taken in the flesh by Doctor Evermann showed that this individual was 36 feet 6 inches long.—M. E. McLellan Davidson, *California Academy of Sciences, San Francisco, California.*

ARTIFICIAL DISTRIBUTION OF FUR-BEARING MAMMALS

Certain fur bearers, such as the river otter, are known to be notorious wanderers under natural conditions. Until recently, in America, each species of fur-bearing mammal was entirely dependent on its own motive powers to extend its range or habitat. However, within the past two years, much of this has changed. Today, numerous individuals involving several species of our native fur bearers are being captured alive and shipped as breeding stock to prospective fur farmers at distant points throughout North America. The following classified advertisement which appears regularly in a leading fur journal indicates the present trend.

> "Animals Wanted:
> "Fur bearers wanted.—Am in market for live mink, marten, skunk, beaver and raccoon. State price and condition in first letter."

In response to the high prices that have been offered for live native fur bearers, enterprising trappers have found it profitable to trap these animals alive and to sell them to dealers in fur-bearing animals, who in turn sell them as breeding stock to fur farmers. Thus, during the fall of 1928, one man in west-central California is reported to have supplied to an animal dealer twelve California lowland minks (*Mustela vison aestuarina*). These minks were shipped to a fur farm in Oregon, many hundred miles beyond their native habitat. Minks are adept at escaping through small cracks and crevices, so that it is probable that, sooner or later, some of these California minks will escape from captivity and resume their existence in a wild state in their new environment.

Another similar instance was brought to my attention on November 11, 1928, when I visited the Highland Mink Ranch, located at Los Gatos, Santa Clara County, California. Here I found a well established mink ranch with eighteen animals, which inquiry revealed came, some from the state of Washington, and the others from Virginia. Further inquiry revealed the fact that the original breeding stock had come partly from the interior of Alaska, partly from Labrador and partly from the state of Washington. It was the intention of the fur farmer in this case to further interbreed and mix the different strains.

It happens that in the Santa Cruz district, between Golden Gate and Monterey Bay, we have no record of mink being native to the region during historic times. We now have minks coming from three distant portions of North America concentrated in this area where minks have hitherto been unknown. It seems desirable

to record these facts at this time, since the tendency to describe geographic races has reached a high development on the Pacific coast. With the possibility of mink escaping from captivity and later being collected in the wild, there will be marked opportunity for someone to discover and describe a "hitherto unknown race of mink in the Santa Cruz district."

Artificial distribution has also taken place in the case of both the golden beaver (*Castor canadensis subauratus*) and the Colorado River beaver (*Castor canadensis frondator*), since specimens of both races were captured alive and taken, in the first instance from the San Joaquin River, near Mendota, and in the second case from the Colorado River between Needles and Yuma, to a fur farm established by the late Will E. Stanfords, at Taylorsville, Plumas County, California. In like manner, he transported the Nevada muskrat (*Ondatra zibethica mergens*) in considerable numbers from Honey Lake, in Lassen County, which lies in the Great Basin drainage area, over the crest of the mountains onto the Pacific slope at Taylorsville. Some of the muskrats were known to have escaped, and it is highly probable that they may succeed in establishing themselves far outside of their normal habitat.

The above instances are only a few of many such transportations that are continually taking place. No published record is, to the author's knowledge, being kept of such transportations of fur-bearing animals, which go on with increasing momentum throughout the United States and Canada. While it is true that the majority of such animals will probably be kept in close confinement on fur farms, it is also equally true that a certain number will escape. Hence, it is the writer's personal belief that from this time on, our native species or geographic forms of fur-bearing mammals will be pretty well "scrambled;" and this fact should be taken into full consideration by mammalogists dealing primarily in systematics.—Joseph Dixon, *Museum of Vertebrate Zoology, Berkeley, California.*

DEATH OF G. F. GAUMER

Dr. George F. Gaumer of Izamel, Yucatan, passed away on September 2, 1929, at an advanced age. Though a Kansan by birth, he had been a resident of Yucatan since 1878. Besides being a practicing physician, Doctor Gaumer was always an enthusiastic collector of mammals. Trapping in every section of Yucatan, he discovered many mammals new to science, several of which have been named in his honor. Doctor Gaumer's chief contributions to mammalogy were his collections, which are scattered among several museums here and abroad, and his "Monografia de los Mamiferos de Yucatan," published by the Departmento de Fomento of Mexico in 1917. In his death we have lost one of our best pioneer collectors.—R. T. Hatt, *American Museum of Natural History, New York City.*

RECENT LITERATURE

Coolidge, Harold Jefferson, Jr. A REVISION OF THE GENUS GORILLA. Mem. Mus. Comp. Zool., vol. 50, pp. 293–381, text figs. 19, pls. 21, maps 2. August, 1929.

Probably no genus of mammals containing so few forms and occupying such a restricted area of distribution has recently been more in need of critical overhauling than the genus *Gorilla*. Lacking knowledge of the limits of individual variation, and pursuing their work separately and without uniformity of methods or standards, zoologists have created no less than two genera, eleven species and four subspecies of these largest of the great apes—all but three of them described within the present century.

Mr. Coolidge has studied the material in practically all of the more important museums of Europe and America. This has given him a "grand total of 393 skulls" (p. 371). Most of these specimens he has measured and photographed on a uniform plan. The measurements of 213 of them are tabulated on pp. 306–329, while the photographs of about a dozen skulls selected to show the extremes of variation are reproduced in plates 4–21. This comprehensive study, the first that has ever been undertaken, leads to the conclusion that there is only one species with two geographical races: *Gorilla gorilla gorilla* inhabiting the region north and east of the Congo River in French Equatorial Africa and the Cameroons as far west as the Cross River, and *G. gorilla beringei* limited to a comparatively narrow strip of mountain forest in eastern Belgian Congo. The area nearly as large as the United States east of the Mississippi River lying between these two regions is apparently uninhabited by gorillas. Exactly why this should be the fact is one of the unexplained mysteries of animal distribution; but, perhaps, with *Ceratotherium*, the genus *Gorilla* may be the victim of an over specialization so excessive that it is now carrying the race to natural death.

The reasons for this holocaust of paper species are set forth in formidably elaborate tables, diagrams and plates which leave little room for doubt that the author's conclusions are, in the main, well founded. Apparently, however, it is possible to refer any sufficiently complete specimen to its proper "race," coast or mountain, on inspection, a state of affairs that might be better indicated in nomenclature by the use of binomial designations. It also seems possible that the further study of other characters than those furnished by the skulls of adult males may show that some of the names now placed in synonymy were actually based on recognizable local races of the two main types.—GERRIT S. MILLER, JR.

Yerkes, Robert M., and Ada W. Yerkes. THE GREAT APES, A STUDY OF ANTHROPOID LIFE. New Haven: Yale University Press. Large octavo, pp. XIX + 652, figs. 172. Cloth, $10.00. August 23, 1929.

"Preparatory to systematic and long-continued utilization of anthropoid apes as objects of psychobiological research, we have catalogued, digested, abstracted, and, as necessary, translated the literature of anthropoid life. Our files are useful aids to the investigator who may be at hand to consult them. This volume is our attempt to share our laboriously achieved informational resources with all who may wish to acquaint themselves generally with the subject, to study aspects of it intensively, or to consult the relevant literature. Only incidentally does the vol-

ume support theses or present hypotheses; it is offered, in the disinterested spirit of science, to promote knowledge and enlightenment through the encouragement of honest, painstaking, unprejudiced observation." Thus, in the first paragraph of their preface, Doctor and Mrs. Yerkes define the object that they had in view when writing "The Great Apes," a work unique in the literature of mammalogy.

The book is divided into six parts as follows: I Historical, II Gibbon, III Orang-Outan, IV Chimpanzee, V Gorilla, VI Comparisons and Conclusions. There is also a "Bibliography for Natural History and Psychobiology of the Anthropoid Apes to 1928" (pp. 593–617) and an elaborate Subject and Author Index (pp. 619–652).

The authors explain the plan of the six parts as follows: "Originally projected as an objective historical account of knowledge of anthropoid life, the manuscript tended to become increasingly critical and original as we proceeded with its preparation. The first two parts—History and Gibbon—are almost wholly historical digests. In them the authors appear as expositors, not as investigators. In the Orang-outan, we quite unintentionally departed from our chosen method because our acquaintance with the type constantly tempted us to supplement the literature and to react to available materials critically and constructively. We departed still further from our ideal of objectivity and aloofness in the Chimpanzee. This was inevitable, since our opportunities for acquaintance with the characteristics of this ape are equaled only by those of Köhler. Finally, in case of the Gorilla we found ourselves the sole possessors of intimate acquaintance with the animal as subject of psychobiological experiments and therefore under necessity of wrting chiefly from the point of view of our own observations. Our task proved unexpectedly complex, long, and difficult. Had we realized in advance how much time it would require and how long it would interrupt our experimental work with the anthropoid apes, we probably should not have undertaken it." If the last statement is strictly true, everyone who has the privilege of using and enjoying this volume must congratulate himself at the thought that the future is as well concealed from psychobiologists as it is from other mortals!

The plan of the book is admirably carried out in all its details. How true this is may perhaps be best indicated by the fact that in the field of taxonomy, where the authors' experience is least and mine greatest, I have been able to find only two noteworthy omissions, namely Winge's general classification of the primates (Pattedyr-Slægter, vol. 2, pp. 253–254, 1924) and Lyon's comparisons of the Sumatran and Bornean orangs (Proc. U. S. Nat. Mus., vol. 34, pp. 676–678, September 14, 1908, and vol. 40, pp. 144–145, April 25, 1911). Winge's views would have added entertainingly to the learned confusion spread on pages 40 and 41. Lyon's notes would have shown that the Bornean and Sumatran orangs are distinguishable from each other by average racial characters not dependent on age or individual. But these are trifling blemishes in an exceptionally satisfying text.

Special attention should be given to the numerous and remarkable photographs. These begin with copies of the crude figures of anthropoids published in the first half of the seventeenth century and lead up to such masterpieces of animal portraiture as the heads of gibbons by Krause on pages 65–70, the young orang by Hartman on page 131, the reclining figure of the gorilla "Congo" by Yerkes on page 457 and the young gorilla and chimpanzee by Hartman on page 531 and also on the paper wrapper. Especially interesting are the many photo-

graphs of chimpanzees solving mechanical problems and undergoing psychological tests.

The ability to meet and master new environmental conditions is a mental feature of the great apes which appeals strongly to our curiosity. I shall therefore close this notice with a short quotation that summarizes one important phase of this subject (p. 577): "Among the primate types appears increasing tendency to modify environment in the interest of welfare and comfort. One of the most impressive expressions of this tendency is the utilization of objects as tools. Search of the literature reveals complete lack of evidence of such behavior in the Prosimiae; indications that only the simplest forms of instrumentation appear in monkeys; abundant proof of the phenomenon in a variety of forms in the anthropoid apes, as also in man. Manifestly, instrumentation becomes increasingly possible and important between lemur and man. Probably it is one of the best indicators of mental status. Assuredly it places the anthropoid apes next to man in ability to achieve adaptation through modification of environment, and at the same time it indicates a great gulf between monkey and ape. Tendency to construct implements, or so to modify environment that objects shall acquire instrumental values, has been observed only in anthropoid ape and man."

Thus we see that, although the application of precise laboratory methods to the psychological study of non-human primates is still in its infancy, it is able to announce a revolutionary result. In the domain of tool using, long regarded as one of the most safely isolated of human provinces, it appears to have moved the great dividing gulf to a position between ape and monkey and to have brought into close contact the mental realms of ape and man.—GERRIT S. MILLER, JR.

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CORRESPONDENCE

THE WORD MAMMALOGIST

Editor of Journal of Mammalogy:

I noticed at the last meeting of the Mammalogists at Ann Arbor that many of the speakers pronounced the words mammalogy and mammalogist as though they were spelled with an o before the l, mammology and mammologist. This is incorrect. The derivation from the word mammal makes it imperative that the a before the l be pronounced like the a in fat. That is also the way it is given in Webster and in the Standard Dictionary. I take it that the mammalogists ought to be the first ones to see to it that their appellation and the name of the science to which they devote themselves should be pronounced correctly.[1]

C. W. G. EIFRIG.

504 Monroe Ave.,
Oak Park, Illinois.
July 9, 1929.

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[1] Professor Eifrig's letter is to the point. Some of us have long noticed the frequent mispronunciation of the words mammalogy and mammalogist, but have taken it as a matter of fact, along with the mispronunciation of many other words we commonly use in scientific parlance, such as adult, nomenclature, research, data, and others. There is, however, in the case of the words mammalogy and mammalogist a special reason for our tendency to mispronounce them. These words are not derived from the word mammal, as Professor Eifrig suggests, but from the words Mammalia + ology and Mammalia + ologist, which properly combined would give us the words mammaliology and mammaliologist. The third and fourth syllables have been dropped from each to produce our customary spelling, yet some are still inclined to retain in pronunciation the *ol*ogy and *ol*ogist. In England the more correct words mammaliology and mammaliologist are sometimes employed.—*Editor*.

COMMENT AND NEWS

The American Society of Mammalogists has been fortunate in maintaining growth during the ten years of its existence, but this has been accomplished only by the expenditure of great effort on the part of the corresponding secretaries. It is becoming increasingly difficult to sustain this rate of increment, and it appears that the best interests of the society can be served by adding to our organization a department with the sole function of increasing the membership. The chairmanship of such a membership committee is not an easy one to fill, as its incumbent must not only be a man of ability and initiative, but have more than a moderate interest in the society, and time to give to its affairs. The society is fortunate, therefore, in procuring for the chairmanship of this committee William P. Harris, Jr. To add materially to the membership of the society is a difficult undertaking and success can be attained only with the help of the present members. It is hoped that the fullest measure of coöperation will be accorded Mr. Harris.

Dr. Leon J. Cole has called to our attention an anonymous article on "The muskrat in Europe," which appeared in *Nature* (vol. 123, p. 775, May 18, 1929). This note summarizes so well the status of the muskrat in Europe that we publish it entire. It reads:

> In 1905 the American muskrat (*Fiber zibethicus*) was introduced into Bohemia on an estate near Prague, where it was hoped that it would breed and help to supply the demand for musquash fur which was then in fashion. The experiment succeeded better (or worse) than was expected, for the colony burst out of control and soon mid-Bohemia was overrun. About 1914, Bavaria and Saxony were invaded; in 1924 Silesia; and in 1928 the outposts were still spreading (Hj. Broch in Naturen, January, 1929). The extent of the conquest may be judged by the fact that in 1921, 60000 to 80000 muskrat skins were sold in Berlin at prices which compared favourably with those obtained for American skins. Such an invasion could not but have its ill-effects. The muskrats, largely vegetarians, have attacked corn, potatoes, kohlrabi, turnips, and carrots. They have extended their carnivorous diet to frogs and fish, and the damage caused by their burrows to road and railway works has not been negligible. Strenuous measures have been adopted against the pest in the affected countries; in Bavaria special muskrat catchers have been appointed. The whole story is but another illustration of the danger of introducing animals in casual and unconsidered ways to new countries, and it strongly supports Dr. Broch's plea that there should be no relaxing of the law forbidding the importation of live muskrats into Norway.

Members of the American Society of Mammalogists will doubtless be interested to know that a survey of animal problems in national parks was undertaken, at

the invitation of Horace M. Albright, director of the National Park Service, on July 1, 1929, by Joseph Dixon and George M. Wright. The object of this investigation is to make a survey of animal problems in our various national parks and to seek means whereby such problems may be solved. It is proposed that certain outstanding problems, such as the bear and deer problems in Sequoia and Yosemite National Parks, the elk problem in Yellowstone and Yosemite, and the mountain sheep, caribou, wolf, and coyote problems in Mt. McKinley, be given major attention at the start.

The relation of predatory animals to other members of the fauna of the parks will be given special attention by Mr. Dixon. Since both of the investigators are members of the society's committee on economic mammalogy and are much concerned regarding this relation, special emphasis will be placed on this phase of the work.

Mr. Wright, a graduate of the School of Forestry of the University of California, is keenly interested in the ecology of plant life in the parks. As an illustration of one of the problems in this line, we may cite the fact that in several well known instances in Yosemite the meadows are being encroached upon extensively by a vigorous growth of young yellow pines, with consequent changes in the animal life of the meadows.

Problems arising through the increasing human occupancy of our national parks and the resultant effect upon the native fauna and flora will also be studied.

This investigation is made possible through the generosity of Mr. Wright, who has assumed the financial responsibility for the work and who, in order to insure the successful completion of the project, has created an independent trust fund under which the work is to be carried out. Headquarters and office for the survey will be maintained at Berkeley, California.

Mr. Wright retains his connection with the National Park Service and is to be its representative in all official matters, with title as scientific aid in investigation. Mr. Dixon retains his title and position as economic mammalogist in the Museum of Vertebrate Zoology, University of California. Mr. Dixon and Mr. Wright both expect to concentrate their energies upon the objectives above outlined; they have therefore been granted freedom from their routine duties in the University of California and in the National Park Service, respectively.

It is planned that facts and conditions as found by personal contact with the living animals in their natural habitats in the parks will be illustrated by a series of both still and motion pictures. Specimens of plants and animals will be collected to insure identification in doubtful cases. It is hoped that the facts thus ascertained will also be useful in the general program for increased activity in the educational work and in the management of animal life in the various national parks.

Full presentation of facts as found, together with recommendations for administrative action, as the work progresses, has been asked for by Director Albright, to whom the investigators will report directly. A concluding general report, based upon the two years' study, is planned.

Dr. Remington Kellogg and Norman Boss of the U. S. National Museum left Washington on October 3 for western Alabama to collect fossils for a period of one month. This expedition is being carried on in coöperation with the Carnegie Institution of Washington, and will seek especially specimens of zeuglodonts.

An editorial on "Who is a conservationist?" from the *Fairmont* [Minnesota] *Daily Sentinel*, as copied in *Fins, Feathers and Fur* (no. 73, p. 107, May, 1929), runs in part as follows:

> Much of this conservation talk and effort is mere twaddle.
>
> Many conservationists merely want to head off the other fellow so that they can do the destroying themselves.
>
> There is an overload of that spirit in the numerous organizations claiming conservation as their object.
>
> A real conservationist should be devoted to some such program as this:
>
> Be content to see migratory fowl resting upon our waters or pursuing their journeyings without wanting to shoot and kill;
>
> Look upon the fur bearing animals in their natural habitat without coveting the money their hides will bring on the market;
>
> Behold a forest without a mental calculation as to what they would put into his pocket when reduced to lumber or other products;
>
> Consider a lake or stream without wanting to drain and destroy it for the sake of a few tillable acres;
>
> Permit fish to inhabit the waters without the primal urge to yank them hence and hear them sizzle in the skillet that he may gorge on what he probably does not need;
>
> Gaze with pleasure upon the beauty of wild flowers without the ruthless impulse to gather them and cause their disappearance.
>
> The true conservationist carries no rod or gun, yet gains the greatest pleasure from nature.
>
> There is but one way to conserve.
>
> That is to quit destroying.

Many and diverse opinions have been expressed in regard to the predatory mammal control letters published in the last number of the JOURNAL. Your editor believes, however, that all will agree on the desirability for the control, if not complete extermination, of one certain species of predatory mammal. He refers to the modern "hack writer." Hack writers are not legitimate reporters. They are connected directly with no newspaper or magazine. They commercialize the wisdom of others. They prowl around a man's office, and at the first opportunity sleek in and attack their prey. They tantalize their victim, and extract from its brain such titbits as please their appetites. These they garble, swallow and try to digest. After some little assimilation the conglomeration is transferred at no small remuneration to some publishing syndicate, which attempts therewith to fertilize the minds of an unsuspecting public. The predator then seeks another victim.

W. E. Hoy, Jr., formerly professor of biology in the Presbyterian College of South Carolina, has been appointed professor of biology in the University of South Carolina, at Columbia, S. C.

The Wild Life Preservation Society of Australia is making a determined effort to save the native fauna of that country, particularly of Queensland. The open season in Queensland began July 8, when shooters, trappers and poisoners turned

loose on marsupials. We quote from the *Sydney Evening News* of July 6, 1929, kindly supplied your editor by Dr. W. L. Abbott:

> The society states that although the recently-elected Premier of Queensland, Mr. A. E. Moore, makes special mention of "opossum," there can be no doubt that the Koala, or native bear, will, as occurred in August, 1927, fall a victim to the class of people who are exterminating our fauna. "They will certainly not discriminate," the society states, "and both kinds of pelts will go out to U. S. A., Canada, and England, in hundreds of thousands.
>
> "Without the issue of export permits, this cannot be accomplished, but all appeals in August, 1927, to the Prime Minister, Mr. Bruce, and the then Minister for Customs, the late Mr. H. E. Pratten, were ignored, until the Society had questions asked in the House of Representatives as to why permits were being issued. These questions were strengthened by the Society prosecuting the holder of thousands of native bear skins in a Sydney store.
>
> "It is the old tale of the political 'catch vote,' and, unless our people awaken to the facts, in another ten years our interesting fauna will be entirely wiped out, so as to supply foreign markets. This is not a question of interstate trade. Therefore, there is no excuse for the slaughter.
>
> "The two main points are, that the N. S. W. Government can seize any skins coming across the border, under the Birds and Animals Protection Act of N. S. W., and the Federal Customs Depot can refuse to issue permits for the export of skins."
>
> The Society states that for a number of years all eyes had been on Queensland, where the Koala had prospered amazingly, at a time when it was doing very badly in New South Wales and Victoria. Queensland remained the stronghold in Australia of the Koala, and naturalists looked more and more to that State as a source for re-stocking the bushlands of Eastern Australia with the marsupial.
>
> Ten years ago, however, the people of Australia were shocked upon hearing the almost incredible stories of the vast numbers of native bears which were being destroyed in Queensland for their skins. In 1919 the Government determined to protect the animal. But the making of a close season by law did not end the slaughter, and illicit killing went on apace.
>
> It was subsequently discovered that the "wombat" skins exported from Sydney were native bears. A still closer investigation showed that more than 600,000 pounds weight of these skins had been sent out from Sydney—nearly all of which were from Queensland, and all during a period when the animal was protected by law throughout the whole of Australia!

In *The Sun* [Sydney] of July 7, 1929, appears a full page account of the koala, or "Australian native teddy bear," lavishly illustrated with excellent halftones. It is earnestly hoped that such an interesting and harmless mammal as the koala may be salvaged from the rampage of commercialism.

Adoph Murie (Ph.D., 1929) has been appointed assistant curator of mammals in the Museum of Zoology, University of Michigan.

Full particulars regarding the next meeting of the society will appear in the February number of the JOURNAL, but members may now be reminded that the dates are May 20 to 24, and headquarters will be at Hotel Emerson, New York City.

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